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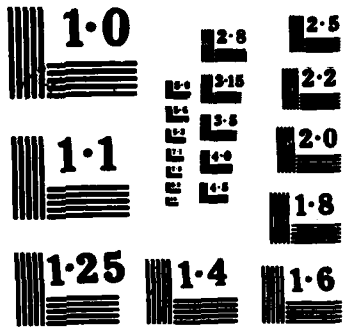
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Joint Test Project Report of Combat Air Support Target Acquisition Program

SEEKVAL

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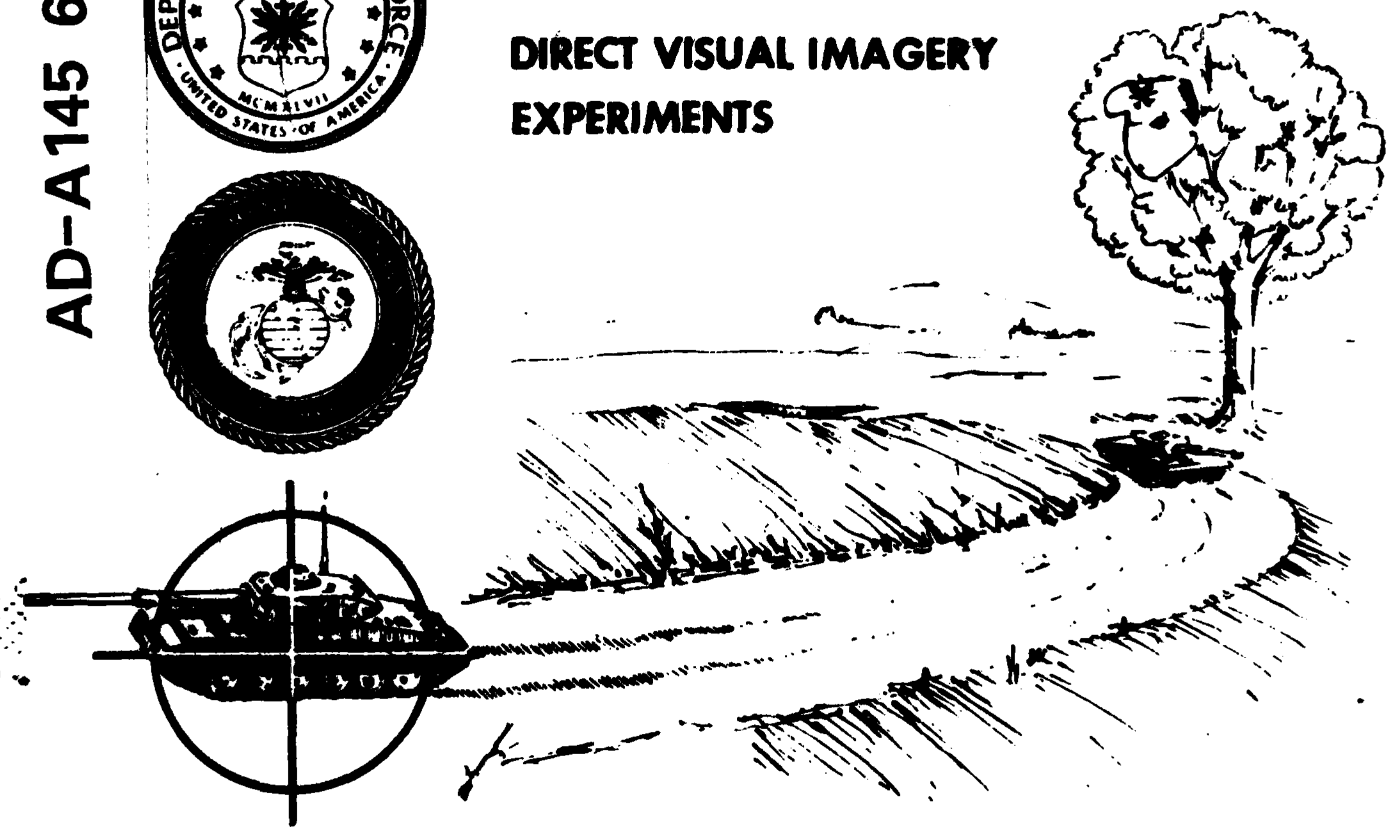
FINAL REPORT IA2

DIRECT VISUAL IMAGERY EXPERIMENTS



JANUARY 1975

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SEEKVAL PROJECT IA2

DIRECT VISUAL IMAGERY EXPERIMENTS

FINAL REPORT

JANUARY 1975

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FOREWORD

This report describes the Direct Visual Target Imagery Experiment for the Combat Air Support Target Acquisition Program (SEEKVAL) in response to SEEKVAL Project Plan IA2, July 1973. The following personnel were responsible for the conduct of the test:

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The assistance of the following organizations is gratefully acknowledged:

United States Army Aviation Center
Twelfth Air Force
Third Marine Air Wing
Ninth Infantry Division
USN Tactical Electronics Warfare Wing

SUMMARY

This report describes the direct visual target imagery experiment, SEEKVAL IA2. The experiment was conducted by the Boeing Aerospace Company under contract to SEEKVAL Joint Test Force (JTF) to develop a suitable methodology to measure target/background effects under varying conditions of airspeed, briefing levels and detection cues on visually unaided target acquisition performance. The overall objective of the Joint Test Program is to provide an evaluation of alternative systems and techniques for acquiring targets in Combat Air Support missions.

The objectives of the initial experiment were to determine the variance among individual observers in their capabilities to acquire targets and to determine whether a meaningful measure of clutter could be defined objectively. Simulation, field trial validation, and analysis provide an economical means to address this complex problem. Four studies were conducted for this experiment: Dynamic Imagery, Complexity, Ambiguity, and Static Detection. In the Dynamic Imagery Experiment, experienced aerial observers searched for targets in colored films shown in a simulator under various conditions of flight speed, pre-flight briefing and inflight cueing. In the Complexity study, observers were shown pairs of slides and were asked to judge in which slide of the pair it would be easier to find and identify targets. A modified paired comparison design was employed to produce a scale of scene complexity over the 24 Oklahoma scenes and two representative terrain table (IA1) scenes. In the Ambiguity study, observers counted cues and target-like objects. A scale for the Oklahoma and terrain table scenes was produced from the data. In the Static Detection Study, observers were asked to find and designate small tactical targets when searching statically presented target-area approach scenes. Elapsed time to target designation and equivalent observer-target range were used as measures of performance. The data from the complexity, ambiguity and static detection studies was combined with several physical measurements into a regression analysis in an attempt to predict target acquisiton performance in the Dynamic Imagery Experiment. The effects of six different controlled conditions on dynamic acquisition performance were tested. Based on 10 predictors the regression equation correlated as high as 0.91 (Forward Air Controller Condition). Without cues and with limited prebriefing information and an airspeed of 360 knots, a correlation of 0.77 was found. The criterion variable used was Weighted Mean Acquisition Range (ACQR).

Maximum available range (MAR) proved to be by far the best predictor. MAR is a composite measure of all ground scene, flight-related and simulator characteristics which establishes a limiting observer-target range for meaningful acquisition. MARs were determined by a group of target acquisition research specialists using the Boeing Multimission Simulator.

The four studies comprising this experiment are important to other SEEKVAL experiments. Formulation of a suitable data base is essential for comparison of target acquisition performance when acquisition aids such as infrared are introduced. The methodology demonstrated by this experiment shows great promise for the formulation of such data base, but minor improvements are necessary to attune the aggregate scale measure for greater sensitivity. Additional study should be made before new imagery is collected for future SEEKVAL experiments to assure that analysis techniques are improved, existing measures are refined and new measures are introduced.

CONTENTS

ILLUSTRATIONS

TABLES

Table		Page

ABBREVIATIONS AND SYMBOLS

A . . . . conditions by targets matrix of predicted acquisition ranges

a_{jk} . . . . . . predicted acquisition range for target k under condition j

AA . . . . . . antiaircraft

acft . . . . . aircraft

ACQR. . . . . . weighted mean acquisition range

AGL . . . . . . above ground level

B . . . . visual angle

b_j . . . . . . constant term associated with the regression equations for condition j

BGNDLU . . . . background luminance (measured in footlamberts)

C . . . . condition in the Dynamic Imagery Experiment

C . . . . contrast

ETA . . . . . . estimated time of arrival

ETE . . . . . . elapsed time enroute

FAC . . . . . . forward air controller

FOV . . . . . . field-of-view

FROG . . . . . free rocket over ground

IP . . . . . . initial position

KIAS . . . . . knots indicated airspeed

kts . . . . . . knots

L_B . . . . . . background luminance

L_T . . . . . . target luminance

M . . . . . . mission in the Dynamic Imagery Experiment

MAR . . . . . maximum available range

NM . . . . . . nautical miles

p . . . . . . probability

p(correct) . . proportion of correct acquisitions

p(incorrect) . proportion of acquisitions of non-targets, either recognized or unrecognized

p(miss) . . . proportion of non-acquisitions

p(premature) . proportion of correct acquisitions made before MAR

p < (some number) . a statistical statement that the effect referred to is statistically significant at the 100 (1-that number) % level of confidence

POL . . . . . petroleum, oil and lubricant

R . . . . . . multiple correlation coefficient

R . . . . . . screen to observer distance

r . . . . . . bivariate correlation coefficient

RTG . . . . . range-to-go

SAM . . . . . surface-to-air missile

SPR . . . . . search performance ratio

T . . . . . . terrain table target approach area with added trees

T . . . . . . true heading

$\tilde{T}$ . . . . . . terrain table target approach area without added trees

tgt . . . . . target

TGTCON . . . . target contrast

V . . . . variables by targets matrix of static target measures

v_{ik} . . . . . . independent variable i measured on target k

VISAFL . . . . visual angle subtended by the longest dimension of the target array (measured in milliradians)

VISAFS . . . . visual angle subtended by the shortest dimension (normal to the longest dimension)of the target array (measured in milliradians)

VISANL . . . . visual angle subtended by the longest dimension of a representative element of a target array (measured in milliradians)

VISANS . . . . visual angle subtended by the shortest dimension of a representative element of a target array (measured in milliradians)

W . . . . conditions by coefficients matrix of regression coefficients

w_{ij} . . . . . . regression coefficient (or weight) for variable i in condition j

z . . . . standard score

GLOSSARY

acquisition	correct detection and identification of a target.
ambiguity index	measure of the target-dependent scene characteristics of a target approach area.
angular subtense	size of visual angle occupied by an object in an observer's field of view.
briefing	period of time used for studying written and pictorial information in preparation for a flight.
clutter	objects, natural or artificial, other than the target tending to hinder target acquisition.
complexity index	measure of the target-independent scene characteristics of a target approach area.
condition	a particular combination of inflight cueing, briefing level and aircraft speed.
cue	an item, feature or signal that enhances target detection.
cueing	visual or auditory inflight aids to target acquisition.
cumulative probability ogive	performance curves showing cumulative acquisition probability as a function of range to target which are obtained by least-squares quadratic curve fitting of normalized data.
dynamic	continuous motion-picture based data, information, or study.
flight	a trial in the simulator characterized by a particular condition-mission combination.
imagery	air-to-ground films or slides of the flight course.
initial position (IP)	prominent landmark at the beginning of a mission used for spatial orientation.

luminance	the photometric term corresponding to radiance; specifies the amount of luminous flux radiated from an extended body per solid angle and per projected area of radiating surface.
masking	natural or artificial features that conceal a target from view.
maximum available range (MAR)	ground distance between nadir/abeam of target and point where target is first visually available.
mission	a flight course containing one IP and four targets.
nadir	point along the flight path where the target is directly beneath the aircraft.
oblique photograph	air-to-ground photograph looking forward along flight path.
photometer	an instrument that measures radiation in the visible spectrum.
pictomap	1:50,000 scale map based on aerial photography and showing picture-like detail of ground features.
premature acquisition	an identification of the correct target area before the target itself is visually available.
resolution	a measure of the smallest detail that a system can discriminate.
search performance ratio (SPR)	proportion of the range in which a target is visually available expended in searching for the target: SPR=(MAR-R)/MAR = 1-(R/MAR)
scene	the air-to-ground view contained in a frame from the dynamic imagery.
static	individual motion-picture frame based data, information or study.
target approach area	visible ground area between MAR and target.

test flight	a trial in the Dynamic Imagery Experiment in which data was collected.
vertical photograph	air-to-ground photograph looking directly downward.
weighted mean acquisition range	average ground distance (in feet) from the acquisition point to the target for a particular group of responses in the Dynamic Imagery Experiment; includes correct acquisitions between MAR and the target and zero range for non-acquisitions.

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SEEKVAL PROJECT IA2 DIRECT VISUAL IMAGERY EXPERIMENTS

1. INTRODUCTION

a. General. This report describes the SEEKVAL direct daytime unaided visual imagery experiment conducted in response to SEEKVAL Plan IA2, July 1973, as amended. The main body of this report summarizes the contractor's report and discusses the impact of that report on methodology for measurement and evaluation in other SEEKVAL experiments. Annex A is the contractor's report. Annex B is a subjective evaluation prepared by the project manager, and is included in this report as informational material which may be of benefit to the overall SEEKVAL program. It is a detailed discussion of the exploratory nature of the project and how the results of the direct visual imagery experiments interface with other SEEKVAL experiments.

b. Hardware. The Multimission Simulator combines a motion picture projector, a spherical section wide-angle screen, a cockpit and peripheral controls. The contractor's report includes a detailed description.

c. Employment Concept.

(1) Static Imagery. Slides representing ten (10) discrete ranges for each of 24 target encounters extracted from JTF-2 film were employed in three ways. A selected group of experienced aircraft observers judged clutter using a method of paired comparisons. Another similar group judged the number of cues and target-like objects or areas in each scene. A third group of subjects sequentially viewed ten still frames of each of the target encounters for a fixed time interval, starting at maximum range and ending when the observer detected the target. This provided a measure of target detection difficulty for each encounter based on elapsed viewing time. In addition, measures of contrast, luminance and target dimensions were obtained.

(2) Dynamic Imagery. Dynamic Imagery Experiments were conducted on the Multimission Simulator to measure dynamic target acquisition performance against the same 24 target encounters selected from the JTF-2 imagery.

2. PURPOSE AND OBJECTIVES

a. Purpose. The Direct Visual Target Imagery Experiments were designed to identify potentially effective measures of target and scene characteristics and develop a methodology for employment of these measures to best predict real-time acquisition performance. These experiments, restricted to unaided acquisition, were intended to establish a

limited base of visual acquisition performance data relevant to the simulator approach. It should be emphasized that this project was exploratory in nature and restricted to providing only a preliminary indication of the effectiveness of dynamic simulator validation of predictions based on static imagery.

b. Objectives. The Direct Visual Target Imagery Experiments were conducted to determine:

(1) The degree to which two proposed static imagery techniques for measuring scene complexity (subjective observer judments and count of perceived target-like objects or areas) predict the portion of dynamic target acquisition performance variation which is attributable to aircraft speed, prebriefing and cueing.

(2) The degree to which observer detection times in response to range-sequenced static imagery predicts observer detection ranges for dynamic presentation of the same scene.

(3) The degree to which a best combination of the static measures in objectives (1) and (2) predict dynamic target acquisition performance under variations in aircraft speed, prebriefing, and cueing.

(4) A methodology for accomplishing and generalizing the best predictor of objective (3).

(5) The proportion of observer variability in target acquisition performance in a typical set of trained military observers attributable to differences in observers.

(6) The contribution of cueing main effects and of interactions among aircraft speed, level of detail in prebriefing, and level of detail in cueing to observer variability.

(7) The correlations between target acquisition performance and the contrasts of the targets, the angular subtenses of the targets and the background luminances.

3. METHOD OF ACCOMPLISHMENT. The Boeing Multimission Simulator was employed to project JTF-2 motion picture imagery filmed in Oklahoma. Experienced aerial observers viewing the imagery on a 160 degree spherical screen indicated when targets appearing in the film were acquired. Weighted mean acquisition ranges (ACQR) computed from observer responses were correlated with target/background parameters obtained from static imagery. Finally, a regression equation was derived to predict observer mean acquisition ranges from physical and phychophysical target/background parameters such as luminance, size, contrast, judged scene complexity and number of target-like objects.

4. RESULTS AND DISCUSSION

a. General. SEEKVAL IA2, basically an exploratory experiment, was designed to develop methodologies for measurement and evaluation of controlled variables in other SEEKVAL experiments. The implications of this experiment and their impact on other SEEKVAL experiments are discussed initially to provide perspective for the summarized contractor's report which follows. Annex A is the full experiment report. Annex B is a detailed discussion of the implications; referenced paragraphs are in parentheses.

b. Implications.

(1) This series of direct visual imagery experiments has demonstrated that the methodology developed here holds promise for future application in developing a reliable unaided visual data base for future SEEKVAL experiments.

(2) The power and potential of the empirical approach to the target acquisition problem was well demonstrated. The good predictive results, the clarity with which methodological improvements can be defined and the potential for eventual taxonomy of target/background related variables support the value of the empirical approach as an augmentation to the analytical approach (2d).

(3) Refinements and improvements to the methodology tested in this experiment can increase insight needed for improved predictiveness for Experiment IB2. Some predictive methodology, either that developed in Experiment IA2 or another methodology, must be applied to Experiment IC2 imagery if an improved ability to treat target/background effects is to be gained (2e).

(4) Imagery, some of the dependent variables, and several of the independent variables considered in Experiment IA2 will be inappropriate for rotary wing mission profiles (pop-up or nap of earth). Imagery for such profiles will be collected during Experiment IC2 and will require extension of the IA2 methodology. Some new measures adaptable to rotor wing mission profiles must be introduced. Refinement of other measures used in Experiment IA2 is expected to improve their predictiveness for both rotor and fixed wing profiles (2h).

(5) Scene complexity appears to be highly specific not only to the existing clutter or heterogeneity of the terrain at the target site but also to the target expected by the observer. The observer appears to respond to the scene in terms of target-like objects based on his

experience and prebriefing. The more specific his expectancy, the less sensitive he may be to clutter, and the smaller number of target-like objects he may acquire in place of the real target. This may be termed target expectancy, and may be a useful concept for dealing with the relationship between target and background variables (3a(1)).

(6) An indexing scheme characterizing search difficulty based on military consideration of terrain within a search window may significantly enhance predictiveness of target/background measures. The search window would be bounded on the near edge by observer scan limitations due to aircraft speed, on the far edge by visual resolution of the target, and on the sides by expected deviation from planned flight path heading. Within the target window the combat posture determines the logical position of the expected target. Search difficulty within this highly localized area may be described by empirically determined weighting and by size of each tactically feasible sector within the search window. Areas are assumed to be scanned and successively eliminated prior to focusing attention on the logical location of the target within the search window. The area subtense of each foliage category together with a difficulty rating would provide the search window index (3a(1)(b)).

c. Summary of Contractor's Discussion of Results.

(1) Objective 1: Complexity and Ambiguity Scale. Agreement was high among experienced aerial observers who were asked to judge pairs of target scene photographs for ease of finding unspecified small tactical targets. The same was true when subjects were asked to count the number of target-like objects or cues in a scene. These two scales measured well but were less predictive than expected.

(2) Objective 2: Static Detection Study. When observers are shown sequences of slides approaching targets, mean acquisition time varies significantly with target type. Equivalent acquisition range correlated well with the weighted mean acquisition ranges (ACQR) used for the Dynamic Imagery Experiment.

(3) Objective 3: Regression Model Validity. Table 1 shows static prediction of dynamic clutter effects. The aggregate of the static measures showed multiple correlations with weighted mean acquisition ranges (ACQR) in the Dynamic Imagery Experiment of between 0.77 and 0.91 for 6 conditions. Maximum available range (MAR), defined as the greatest distance at which the target was discernible on film, was the strongest predictor. Static detection equivalent range was next, followed by size measures, background luminances, contrast, and complexity or ambiguity.

IA2

TABLE 1. STATIC PREDICTION OF DYNAMIC CLUTTER EFFECTS

Dynamic Test Cells	Correlation*	%Prediction of TGT/Background Variance
Range-to-go, 360 K, Lo-Brief	.8581	73.63
FAC, 360 K. Lo-Brief	.9122	83.21
No Cueing, 360 K, Lo-Brief	.7701	59.31
No Cueing, 200 K, Lo-Brief	.8410	70.73
No Cueing, 360 K, Hi-Brief	.8835	78.06
No Cueing, 200 K, Hi-Brief	.8988	80.78
All IA2 Test Cells	.8774	76.98

*Multiple R, All Static Measures vs. Dynamic Acquisition

(4) Objective 4: Regression Methodology. High multiple correlations were obtained in this project, indicating a good potential for development of a predictive model. Low correlations of individual predictors with weighted mean acquisition range indicate the need for improvement of some individual measures.

(5) Objective 5: Subject Effects. The amount of the variance due to subjects in the Dynamic Imagery Experiment was very small.

(6) Objective 6: Dynamic Imagery Experiment Main Effects. Use of a Forward Air Controller improved target acquisition performances. Use of a range-to-go display did not affect performance. Some observers preferred the more familiar elapsed time clock, and felt that the range-to-go device was redundant.

(7) Objective 7: Individual Correlations. Correlations between weighted mean acquisition range (ACQR) and the physical measures were low indicating that the measures used were insensitive, inaccurate, or that interactions among effects measured were more significant than the effects themselves.

5. CONCLUSIONS. Source of each conclusion is indicated as Annex A followed by the paragraph number.

a. Objective 1: Complexity and Ambiguity Scales. The scales measured well but validity was low. Scenario refinements and imagery selection could improve sensitivity of these scales. Satisfactory reliability can be maintained with fewer observers. Rotary and fixed wing observers performed essentially the same (A-5a).

b. Objective 2: Static Detection Study. Static detection range is a strong predictor of dynamic acquisition performance that discriminates the wide variation in target effects (A-5b).

c. Objective 3: Regression Model Validity. Multiple correlation, taken from the predictors of objectives 1 and 2 as well as all other predictor variables, ranged from 0.77 to 0.91 and indicate that the regression model is highly predictive (A-5c). MAR and static detection range are the strongest predictors. Although the correlation is 0.39 between them, the aggregate prediction is nevertheless valid.

d. Objective 4: Regression Methodology. Further development of the predictive model holds great promise considering possible refinements (A-5d).

e. Objective 5: Subject Effects: In the analyses of variance, variance among subjects was negligible relative to other effects.

f. Objective 6: Dynamic Experiment Main Effects. Target acquisition

performance improved when inflight cueing was provided by a Forward Air Controller (FAC). The range-to-go display did not affect performance. Preflight briefing from target photographs greatly improved performance. Speed differences were statistically significant but small in magnitude. There was no significant speed by briefing interaction (A-5f).

g. Objective 7: Individual Correlations. Refinement of existing physical measures or selection of new ones is necessary to improve correlations with the criterion measure, ACQR (A-5g).

6. RECOMMENDATIONS. The source of each recommendation is indicated as Annex A or B followed by the paragraph reference.

(1) The present methodology for developing an aggregate scale for predicting dynamic target acquisition performance should be retained for future SEEKVAL studies (A-6a).

(2) Masked targets should be avoided in future SEEKVAL experiments to preserve integrity in describing target/background characteristics. If masking cannot be avoided, it should be studied as a separate variable (A-6c).

(3) Decision rules for application of physical measures should be examined and efforts made to develop much needed consistency. New physical measures should be sought that would be sensitive to acquisition performance. Greater precision of physical measurements is necessary (A-6a). The SEEKVAL JTF believes the physical measurements in Table A-12 and the descriptive information on page A-54 are not properly documented in the report; however, the information is on file at Kirtland AFB, New Mexico.

(4) The distinction between target-free and target-specific dimensions should be considered for new psychophysical scales. If a target-specific scale is addressed, then the observer should be briefed on the target. Selection of future target scenes should consider minimizing the number of scenes while adequately representing the target approach (A-6e).

(5) The equivalent range measure from the static detection study should be used in the future studies. A constant range interval rather than constant MAR intervals should be used (A-6f).

(6) Inaccurate range predictions should be investigated in an attempt to discover new predictors (A-6g).

(7) Separate counts of cues that enhance acquisition and distraction points that degrade acquisition should replace the existing count of target-like objects (B-3a(2)(d)).

(8) Complexity and ambiguity predictors should be improved by focusing target search within a search window during static imagery tests (B-3a(2)(f)).

(9) Examination of an array of target photos, one per target, selected on the basis of range at which detection rates were highest, should be conducted to discover possible new physical measures (B-3a(3)(c)).

(10) An interval scale on scene complexity should be developed so that possible interactions between encounters and flight conditions can be examined (B-3b(2)).

(11) Future SEEKVAL test designers may assume no interaction between briefing and speed, thereby simplifying future designs (B-3b(3)).

(12) Field experiment validation of MAR under various levels of atmospheric attenuation with simultaneous imagery collection should be undertaken to determine the effect on MAR of variables other than target parameters and thereby determine to what extent MAR is dependent only on target parameters and how good a measure of perceived target parameters MAR is (B-3a(1)).

(13) The impact of target expectation on perceived complexity should be tested by comparing levels of target specificity with paired comparison correlations to ACQR (B-3a(1)).

(14) If target expectation is to be investigated, cueing by briefing interactions should also be investigated (B-3b(1)).

(15) An indexing scheme that would assess the difficulty within the target search window should be considered as an additional predictor (B-3a(1)).

(16) Fewer subjects may be used in future static experiments (B-3a(2)(a)).

(17) Fewer scenes within each encounter may be used in future static experiments (B-3a(2)(b)).

(18) A complete paired comparison design is desirable for future tests if the paired comparison method is retained (B-3a(2)(c)).

(19) Candidate improvements suggested in this report should be explored before SEEKVAL Experiment IB2 commences (A-6h).

ANNEX A

SEEKVAL

PROJECT IA2

DIRECT VISUAL IMAGERY EXPERIMENTS

CONTRACTOR'S REPORT

THE BOEING AEROSPACE COMPANY

1. INTRODUCTION. The Research and Engineering Division of The Boeing Aerospace Company performed a series of experiments under the overall management of the SEEKVAL Joint Test Director. On-scene management was provided by the SEEKVAL Program Manager. The overall goal of the SEEKVAL Joint Test Program is to develop improved mission-oriented solutions to the problem of visually acquiring targets under real-time operational conditions. Appropriate simulation techniques, together with validating field trials and suitable analytic methods, provide an economical means to address this complex, multi-dimensional problem. The simulation program provides for systematic application of existing simulation capabilities, and at the same time seeks to advance simulation hardware/software technologies to provide and use a fully qualified test facility for the evaluation of advanced acquisition devices and techniques. Throughout this process, reliability, validity, and operational utility of the test data will be used as primary criteria of testing performance.

2. PURPOSE OF THE PROJECT. The specific objectives of this set of studies are stated in the body of the report. Briefly, the objectives were to test the effect on target acquisition of speed, briefing level and several inflight cueing techniques, and to begin to develop a cohesive set of predictors for acquisition performance. These predictors include two subjective scales of target and target approach area difficulty, as well as several physical measures of the target and its environs. The predictive methodology is necessary to develop a model which would include the effective parameters of the complex target acquisition problem and serve as a guide to development of target acquisition doctrines and devices. An effective predictive model would thus help preclude expensive research and development of sophisticated but operationally ineffective hardware.

3. METHOD OF ACCOMPLISHMENT.

a. General Methodology. To accomplish the stated objectives for this program, four data collection efforts were undertaken. The same 24 tactical targets were used in all four studies. In the Dynamic Imagery Experiment, 72 subjects tried to find these targets in colored films shown in a simulator under various conditions of flight speed, preflight briefing and inflight cueing. A group of 100 different subjects participated in the Complexity Study in which the 24 target areas were scaled with respect to scene complexity as an indicator of "clutter." Another group of 100 subjects provided a scale of scene ambiguity by counting target-like elements in the visual scenes leading up to the targets. Twenty more subjects attempted to find the targets when the encounters were presented in a static mode (slides rather than movie presentation.)

The data from the two scaling studies, the Static Detection Study and several physical measurements on the statically projected target imagery were combined in regression analysis in an attempt to predict target acquisition performance in the Dynamic Imagery Experiment.

(1) Subjects. In the dynamic study and the two scaling studies, each of the services provided exactly one-quarter of the subjects. In the Static Detection Study, the subjects were all Marines. All subjects were rated pilots, bombardier/navigators or weapon system employment officers currently assigned to an operational aircrew or so assigned within the last 18 months. No subject participated in more than one of these studies. Subject characteristics are discussed in more detail in the sections describing each study and in Appendix 2 of this Annex.

(2) Imagery. The imagery used in these studies was originally obtained during the Joint Task Force Two (JTF-2) program (Reference 1). In Test 4.4 of that program, a wide variety of tactical targets were deployed over two courses in a wooded and agricultural area in southeastern Oklahoma. The imagery selected for this study was color motion picture film taken at 300 feet AGL over those two courses. The film was taken using a specially configured B-25, equipped with a 70mm motion picture camera having an f/4 lens similar to the one used in the projection system. The camera, which was modified to operate in reverse, was mounted in the rear of the aircraft with the center of the 160-by-60 degree field of view aligned with the plane's longitudinal axis in azimuth and depressed 15 degrees. The reversed camera and rearward filming eliminated a lens-insect splatter problem common on forward looking systems. The imagery was obtained under excellent weather and visibility conditions by flying along the two courses at 175 knots actual ground speed. The resulting film was divided into six missions, each containing a prominent landmark (which was used as the initial position (IP)) and four targets. Table A-1 gives the IPs and targets selected for each mission and Appendix 5 gives detailed target cataloging information.

The six missions, as they were used in the dynamic study, ranged in length from 30.1 to 49.3 nautical miles (NM). The inter-target intervals varied from 1.5 to 20.9 NM. No two targets were in view at the same time. For each target, a range was determined at which that target was first visually available. These distances, called maximum available ranges (MAR) varied from 3,369 to 13,126 feet with a mean MAR of 6,201 feet.

TABLE A-1. SEEKVAL IA2 TARGETS

MISSION

	1	2	3	4	5	6
Initial Point	Orange Marker	Dirt Airstrip	Storage Area	Water Tower	Road Junction	School House
Target 1	AA Battery	Vehicle Park	Tank Platoon	Tank Convoy	AA Battery	SAM Convoy
Target 2	Howitzer Battery	POL Site	Anti-tank Battery	Vehicle Park	SAM Convoy	AA Battery
Target 3	Pontoon Bridge	Howitzer Battery	FROG Site	SAM Site	Truck Convoy	Tank Convoy
Target 4	Towed Howit-zers	Heli-copters	SAM Site	AA Guns	AA Battery	Vehicle Park

The frames mounted as slides for the three static studies and for the physical measurements were taken from a second print of the same negative used for the dynamic prints. These frames were mounted as 35mm slides resulting in a reduction in field of view to 108-by-60 degrees. The frames selected for each target were those at MAR and at 1/10 MAR increments toward the target.

In an attempt to relate this project with SEEKVAL Project IA1 (Reference 2), conducted on the terrain table at the Aerospace Medical Research Laboratory (AMRL), Wright-Patterson AFB, additional slides were obtained from that facility. The slides obtained represent 10 equal increments of closing range on a terrain table target in its "cluttered" state and 10 more in its "uncluttered" state. Cluttered and uncluttered conditions were defined as 60 and 20 trees respectively, in a 200 meter radius about the target site.

b. <u>Dynamic Imagery Experiment</u>

(1) Experimental Conditions. There were six experimental conditions and six missions with an initial position (IP) and four targets each. The conditions were defined as shown in Table A-2 below.

TABLE A-2. DEFINITIONS OF EXPERIMENTAL CONDITIONS

Conditions	Cueing	Speed (knots)	Briefing Level
1	Range-to-go	360	Low
2	FAC	360	Low
3	None	360	Low
4	None	220	Low
5	None	360	High
6	None	220	High

(2) Experimental Design. In the experimental design, the six conditions were organized as shown below in Figure A-1. Note that the design breaks into two substudies with a shared baseline. In the analysis, these two substudies are treated separately, with the three levels of in-flight cueing (Conditions 1 to 3) defining one substudy and the two briefing levels and two speeds (Conditions 3 to 6) defining the other substudy.

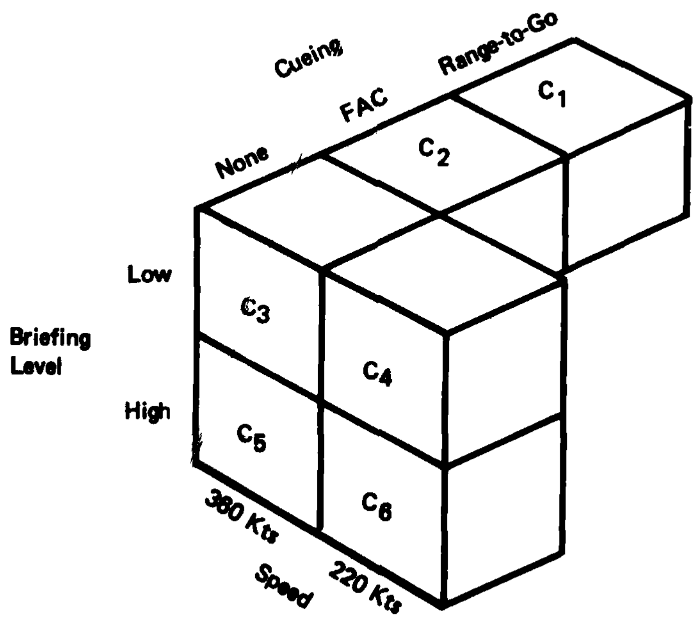

Figure A-1: The Experimental Design — Dynamic Study

The matrix which assigned condition-mission combinations to subjects and flights (or trials) is reproduced in Table A-3. In that Table, the six conditions are denoted C_1 through C_6 and the missions M_1 through M_6. Each subject flew all six of the missions, each under a different one of the six conditions. Since there were four targets in each mission, each subject tried to find a total of 24 targets. All subjects combined made 1728 acquisition attempts. The condition-mission combinations were randomized across trials with the simultaneous constraints such that:

- Each subject flew all six missions and all six conditions;
- No subject experienced more than two speed changes;
- Each of the 36 condition-mission combinations appeared exactly twice in each trial position. This was intended to balance missions with conditions and to spread original learning or fatigue effects evenly across condition-mission combinations;
- The second 36 subjects received condition-mission trial orders which were mirror images of those received by the first 36. This balanced out serial effects such as between-trial transfer.

(3) Subjects. All of the 72 subjects were military flight crewmen with an equal number of representatives from each of the four services. The range in flight experience among the subjects was large, with 34 subjects having been rated flight crew members for 0 to 5 years, 21 for 6 to 10 years, nine for 11 to 15 years and eight for over 15 years. Forty-four of the subjects flew fixed-wing aircraft only, 16 flew helicopters only, and 12 flew both helicopters and fixed-wing aircraft. Fifty-six subjects had combat flight experience in Southeast Asia.

Ranks of the subjects included WO-1, CWO, and all officer ranks between 0-2 and 0-6. One subject was a Flight Lieutenant in the Royal Air Force.

The majority of the subjects (54) were college graduates (seven had advanced degrees), 14 had only some college, and four had no college.

(4) The Simulator and Simulation Equipment. The facility used for the study was the Boeing Multimission Simulator. Briefly, it consists of a motion picture projector, a spherical section screen, a simulator cockpit, and various peripheral control and data-recording devices. Subjects took their flights in the Multimission Simulator and were briefed in a separate room.

Subject	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Subject	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1	C_5M_2	C_4M_3	C_1M_4	C_3M_1	C_2M_5	C_6M_6	37	C_6M_6	C_2M_5	C_3M_1	C_1M_4	C_4M_3	C_5M_2
2	C_3M_3	C_5M_5	C_6M_1	C_2M_2	C_1M_4	C_4M_6	38	C_4M_6	C_1M_4	C_2M_2	C_6M_1	C_5M_5	C_3M_3
3	C_6M_2	C_5M_6	C_4M_3	C_3M_5	C_1M_1	C_2M_4	39	C_2M_4	C_1M_1	C_3M_5	C_4M_3	C_5M_6	C_6M_2
4	C_6M_3	C_1M_6	C_4M_5	C_3M_2	C_2M_4	C_5M_1	40	C_5M_1	C_2M_4	C_3M_2	C_4M_5	C_1M_6	C_6M_3
5	C_3M_4	C_6M_3	C_5M_6	C_2M_5	C_1M_2	C_4M_1	41	C_4M_1	C_1M_2	C_2M_5	C_3M_6	C_6M_3	C_5M_4
6	C_4M_1	C_1M_3	C_3M_5	C_5M_2	C_6M_4	C_2M_6	42	C_2M_6	C_6M_4	C_5M_2	C_3M_5	C_1M_3	C_4M_1
7	C_5M_1	C_4M_2	C_1M_6	C_3M_4	C_2M_3	C_6M_5	43	C_6M_5	C_2M_3	C_3M_4	C_1M_6	C_4M_2	C_5M_1
8	C_6M_1	C_5M_3	C_2M_5	C_4M_2	C_3M_6	C_1M_4	44	C_1M_4	C_3M_6	C_4M_2	C_2M_5	C_5M_3	C_6M_1
9	C_2M_4	C_3M_6	C_4M_1	C_6M_2	C_5M_3	C_1M_5	45	C_1M_5	C_5M_3	C_6M_2	C_4M_1	C_3M_6	C_2M_4
10	C_2M_1	C_1M_2	C_6M_4	C_5M_3	C_4M_6	C_3M_5	46	C_3M_5	C_4M_6	C_5M_3	C_6M_4	C_1M_2	C_2M_1
11	C_1M_1	C_5M_2	C_6M_3	C_2M_6	C_3M_4	C_4M_5	47	C_4M_5	C_3M_4	C_2M_6	C_6M_3	C_5M_2	C_1M_1
12	C_2M_6	C_6M_4	C_5M_3	C_4M_5	C_3M_2	C_1M_1	48	C_1M_1	C_3M_2	C_4M_5	C_5M_3	C_6M_4	C_2M_6
13	C_2M_3	C_4M_4	C_1M_5	C_6M_1	C_5M_6	C_3M_2	49	C_3M_2	C_5M_6	C_6M_1	C_1M_5	C_4M_4	C_2M_3
14	C_4M_6	C_6M_1	C_5M_2	C_2M_4	C_1M_5	C_3M_3	50	C_3M_3	C_1M_5	C_2M_4	C_5M_2	C_6M_1	C_4M_6
15	C_3M_6	C_2M_3	C_1M_1	C_5M_5	C_6M_2	C_4M_4	51	C_4M_4	C_6M_2	C_5M_5	C_1M_1	C_2M_3	C_3M_6
16	C_4M_2	C_2M_4	C_3M_3	C_1M_6	C_5M_5	C_6M_1	52	C_6M_1	C_5M_5	C_1M_6	C_3M_3	C_2M_4	C_4M_2
17	C_6M_4	C_5M_1	C_2M_6	C_1M_2	C_3M_5	C_4M_3	53	C_4M_3	C_3M_5	C_1M_2	C_2M_6	C_5M_1	C_6M_4
18	C_1M_5	C_3M_1	C_6M_2	C_5M_6	C_4M_4	C_2M_3	54	C_2M_3	C_4M_4	C_5M_6	C_6M_2	C_3M_1	C_1M_5
19	C_5M_3	C_6M_6	C_1M_2	C_2M_1	C_4M_5	C_3M_4	55	C_3M_4	C_4M_5	C_2M_1	C_1M_2	C_6M_6	C_5M_3
20	C_3M_5	C_2M_1	C_6M_6	C_5M_4	C_4M_3	C_1M_2	56	C_1M_2	C_4M_3	C_5M_4	C_6M_6	C_2M_1	C_3M_5
21	C_1M_3	C_2M_2	C_5M_5	C_6M_4	C_4M_1	C_3M_6	57	C_3M_6	C_4M_1	C_6M_4	C_5M_5	C_2M_2	C_1M_3
22	C_3M_4	C_6M_5	C_5M_1	C_2M_3	C_1M_6	C_4M_2	58	C_4M_2	C_1M_6	C_2M_3	C_5M_1	C_6M_5	C_3M_4
23	C_1M_2	C_3M_4	C_2M_3	C_4M_1	C_6M_5	C_5M_6	59	C_5M_6	C_6M_5	C_4M_1	C_2M_3	C_3M_4	C_1M_2
24	C_3M_1	C_2M_6	C_5M_4	C_6M_5	C_4M_2	C_1M_3	60	C_1M_3	C_4M_2	C_6M_5	C_5M_4	C_2M_6	C_3M_1
25	C_6M_5	C_5M_4	C_4M_2	C_1M_3	C_2M_6	C_3M_1	61	C_3M_1	C_2M_6	C_1M_3	C_4M_2	C_5M_4	C_6M_5
26	C_2M_5	C_4M_6	C_3M_2	C_1M_4	C_5M_1	C_6M_3	62	C_6M_3	C_5M_1	C_1M_4	C_3M_2	C_4M_6	C_2M_5
27	C_4M_3	C_1M_5	C_2M_1	C_3M_6	C_5M_2	C_6M_4	63	C_6M_4	C_5M_2	C_3M_6	C_2M_1	C_1M_5	C_4M_3
28	C_6M_6	C_4M_1	C_2M_2	C_1M_5	C_3M_3	C_5M_4	64	C_5M_4	C_3M_3	C_1M_5	C_2M_2	C_4M_1	C_6M_6
29	C_5M_5	C_1M_4	C_4M_6	C_3M_3	C_2M_1	C_6M_2	65	C_6M_2	C_2M_1	C_3M_3	C_4M_6	C_1M_4	C_5M_5
30	C_4M_4	C_3M_3	C_6M_5	C_5M_1	C_2M_2	C_1M_6	66	C_1M_6	C_2M_2	C_5M_1	C_6M_5	C_3M_3	C_4M_4
31	C_1M_4	C_4M_5	C_5M_6	C_6M_3	C_3M_1	C_2M_2	67	C_2M_2	C_3M_1	C_6M_3	C_5M_6	C_4M_5	C_1M_4
32	C_2M_2	C_3M_5	C_4M_4	C_1M_1	C_6M_6	C_5M_3	68	C_5M_3	C_6M_6	C_1M_1	C_4M_4	C_3M_5	C_2M_2
33	C_5M_6	C_6M_2	C_3M_1	C_4M_4	C_1M_3	C_2M_5	69	C_2M_5	C_1M_3	C_4M_4	C_3M_1	C_6M_2	C_5M_6
34	C_4M_5	C_3M_2	C_1M_3	C_6M_6	C_5M_4	C_2M_1	70	C_2M_1	C_5M_4	C_6M_6	C_1M_3	C_3M_2	C_4M_5
35	C_1M_6	C_2M_5	C_3M_4	C_4M_3	C_6M_1	C_5M_2	71	C_5M_2	C_6M_1	C_4M_3	C_3M_4	C_2M_5	C_1M_6
36	C_3M_2	C_1M_1	C_2M_4	C_4M_6	C_6M_3	C_5M_5	72	C_5M_5	C_6M_3	C_4M_6	C_2M_4	C_1M_1	C_3M_2

Table A-3 Subjects' Condition-Mission Assignments

(a) The Multimission Simulator. The heart of the simulator is a 70 millimeter motion picture projector modified for variable speed and equipped with a Fairchild f/4 lens. The lens has a focal length of 0.2 inches. The speed parameter of the study was implemented by varying projection frame rate to simulate either 360 or 220 knots ground speed. The projected picture filled a 160 by 60 degree spherical section screen with a 15 foot radius and a high-gain coating to concentrate maximum light from the reflected picture back at the subject's position in the simulator cockpit. In order to place the subject at the optimum viewing position, he was seated in the rear seat of a two-place tandem attack fighter mockup. The cockpit chosen was fully instrumented, but the aims of this study were best served by activating only limited instruments and controls. Aside from lighting intensity controls, only the acquisition button was active. This control was a button on the top of a Bullpup control stick mounted at the left side of the subject's seat. The only active displays were the elapsed time clock mounted on the right top corner of the instrument panel and, in one condition, the range-to-go indicator.

(b) Range-to-go Indicator. Experimental Condition 1 was unique in that the range-to-go device was operating. The subject saw a six-digit indicator count down to the IP and each target from 35,000 feet to zero feet at nadir. If the inter-target interval was less than 35,000 feet, the device started counting on the new target just after passing the preceding one. Zeros were always displayed in the "units" and "tens" spaces of the device to hide information which was moving too fast to be read.

(c) Forward Air Controller. In Experimental Condition 2, subjects had the assistance of a forward air controller (FAC). FAC information was pre-recorded by Major R. N. Connelly of the USAF Air Ground Operations School, Hurlburt Field, Florida. Major Connelly is a highly experienced FAC. During the approach to each target, he gave a description of the target and its surrounding cues, then guided search by giving range and relative bearing during the approach. A transcript of the FAC tapes is contained in Appendix 1.

(5) Briefing Materials. Prior to each flight, the subjects were provided with a set of briefing materials appropriate for their next condition-mission combination. These included a written description of the flight path and targets, a flight plan, a map folder, and a condition description. In addition, they received a set of scales appropriate to the map folder, a pair of dividers, and a grease pencil. In the high briefing level conditions subjects were also given a notebook of briefing photographs. Subjects were allowed to take only the map folder and flight plan into the simulator. These materials are described below. The written materials are reproduced in Appendix 1 to this Annex.

(a) Written Descriptions. Each written description contained a general discussion of the course, followed by a more detailed description of the flight path, IP and targets. The flight path descriptions included location, visual cues available in the area, general headings, and distances flown in each segment of the course. Targets were discussed in terms of appearance and arrangement of target elements and their relationship to the surrounding area.

(b) Flight Plans. A flight plan was compiled for each of the subjects' condition-mission combinations. Listed in these charts were mission altitude, speed, weather conditions, approach headings to the IP and targets, and cumulative distance and time (minutes plus seconds) from mission start to the IP and targets. There was also room for the subjects to enter any notes they thought would be helpful.

(c) Map Folders. Mission flight paths were depicted in sets of maps arranged in an 8 ½ by 11 inch booklet format. Each booklet contained, first, a 1:250,000 scale topographic map showing the entire mission area on one page or two facing pages, and then several pages of 1:50,000 scale pictomaps. The pictomaps, rich in visual detail, covered the entire course and were oriented in the folders heading up. Labels were added to the maps to show target identities and locations and flight path headings. A four mile wide corridor was shown on the maps, and subjects were told they would always be somewhere within that corridor, though not necessarily along its centerline. Pages of the map folder were plastic covered so that the subjects could make notes in grease pencil.

(d) Condition Descriptions. Information in the condition descriptions included mission speed, available briefing materials, and available inflight cueing.

(e) Briefing Photography. In the high briefing level conditions, subjects were given a notebook of high quality monochromatic vertical and forward oblique aerial photographs of the area surrounding each IP and target. The vertical photographs were approximately 1:25,000 scale and the coverage of the oblique photographs was selected such that each target and its surrounding area were shown in detail.

(6) Conduct of the Study. This section contains a description of the way in which the subjects performed their assigned tasks and the way in which the data generated by the subjects was used to develop the basic information for the analysis to follow. The written and taped material is reproduced in Appendix 1.

(a) Schedule. The data collection phase of this study extended from 12 November 1973 through 29 January 1974. During this period, a total of 72 flight crewmen participated, two at a time. Each subject served from 1230 to approximately 1700 one afternoon and from 0800 to approximately 1200 the next morning.

(b) Procedures. When each pair of subjects arrived at the test site, they were seated in the briefing room and tape recordings of the Introduction for Subjects and the General Instructions and Ground Rules were played for them. Transcripts of these were available in written form for their later reference. This was followed by a short briefing period prior to the familiarization flight. The materials provided for this flight were similar to those given for the subsequent test flights: a map folder with 1:250,000 and 1:62,500 scale maps, a flight plan, a written course and target description and a description of the conditions for that flight. Subjects were told that the briefing officer would calculate time-rate-distance problems for the checkpoints they selected if they wished. When the subjects had finished briefing, they were both taken to the simulator where another tape was played describing the simulator.

While the familiarization mission was flown, one of the subjects was seated in the simulator cockpit and the other watched from the projection stand. The flight was accompanied by a taped commentary which further reviewed target acquisition as it was to be accomplished during this program. The familiarization flight was then flown a second time with the other subject in the cockpit.

During this second flight, the subject who had already flown returned to the briefing room to prepare for his first test flight. He was given briefing materials appropriate to his assigned condition and mission and was allowed as much time as he needed for briefing. When the second subject had completed his familiarization flight, he returned to the briefing room to prepare for his first test flight, and the first subject went back to the simulator to fly his first test flight. A brief target designation review was read to each subject just prior to his first test flight. Thus, for the afternoon session, the two subjects alternated briefing and flying until each had completed the familiarization flight and three test flights. The next morning they resumed the alternation, each flying three more test flights.

(c) Data Collected. The primary data from this study was that describing target acquisition performance in the simulator. For each IP and target, the fact of non-acquisition or the number of the frame of the film on the screen at the time of the acquisition was recorded. This data set is complete for the 1728

acquisition attempts except for four targets lost for each of two subjects when the range-to-go device failed. Rather than run two additional subjects, it was decided to synthesize this small amount of data using these two subjects' scores on the other five conditions and the other subjects' scores on the range-to-go condition.

It will be recalled that each mission contained an IP and four targets. Subjects were instructed to report acquisition of the IP as if it were a target. Thus, the IPs served as warm-up targets on each flight. The subjects could use the IPs to check their elapsed time clocks and to familiarize themselves with the conditions of that flight before the targets appeared. For this reason, while data was collected on IP acquisition, it was not included in the analysis.

Sometime during his participation in the study each subject completed a biographical questionnaire. After each flight he completed a flight debriefing questionnaire to help assess the value of the briefing materials and inflight aids used in that flight. At the completion of the six flights there was a final debriefing questionnaire to assess impressions of target acquisition in general and this simulation in particular. These questionnaires and summaries of the responses to them are described in Appendices 2 and 3 to this Annex.

Subjects' color vision was tested with plates 1-6 of American Optical's H-R-R pseudoisochromatic plates. Visual acuity was tested using the American Optical Sight Screener. These results are reported in Appendix 2.

c. Complexity Study.

(1) Design. The Complexity Study used a modified paired comparison technique to obtain ratings of complexity for the set of 26 target approach areas (the 24 SEEKVAL IA2 targets and the two from IA1). Subjects were each shown 325 pairs of slides and asked to judge in which slide of the pair it would be easier to find and identify targets. Each target approach area was paired with each other target approach area for N(N-1)/2 or 325 pairings. The 100 subjects thus yielded 32,500 data points.

Each of the 26 target-approach areas was covered by five air-to-ground scenes in order to have a more representative spectrum of ground features contained in that target-approach area.

Air-to-ground scene pairings and presentation orders were randomized for each group of observers with the restrictions that:

- No pair could contain scenes of the same target-approach area.

- Each air-to-ground scene appear an equal number of times in each set of 325 pairings.

- Target-approach areas appear an approximately equal number of times left and right.

- No pair could appear more than once in each set of 325 pairs.

(2) Subjects. The majority of the 100 subjects (90) had been flight crewmen in one of the four military services for 10 years or less, while 10 subjects had been military flyers for 11 years or longer. Sixty-one subjects had operational experience with fixed-wing aircraft only, 23 with helicopters only, and 13 had experience with both fixed wing and rotary wing aircraft. Eighty-three subjects had combat flight experience in Southeast Asia.

Military ranks represented by the subjects included WO-1 through CWO-3 and O-2 through O-4.

Thirty of the subjects had some college education, and 70 were college graduates (10 of these had advanced degrees).

(3) Equipment and Materials. The air-to-ground scenes covering each target-approach area represented five proportional increments of the range in which the target is visually discriminable from its background. The discrete ranges used were at 20, 40, 60, 80 and 100 percent of this "maximum available range."

Slide pairs were presented using two Kodak Carousel 860H, 35mm projectors having five-inch f/2.8 lenses. An electrical sequence-control timer operated the two projectors in parallel, changing slides in both projectors every 10 seconds. Other support equipment included two projection screens with a minimum size of 50 x 50 inches.

Room and seating arrangements for this study are shown in Figure A-2.

(4) Conduct of the Study. This section describes the sequence of events during a typical experimental session and the data generated during this experiment.

(a) Schedule. The data collection phase of this study extended over a seven-week period as shown in Table A-4 at the locations indicated.

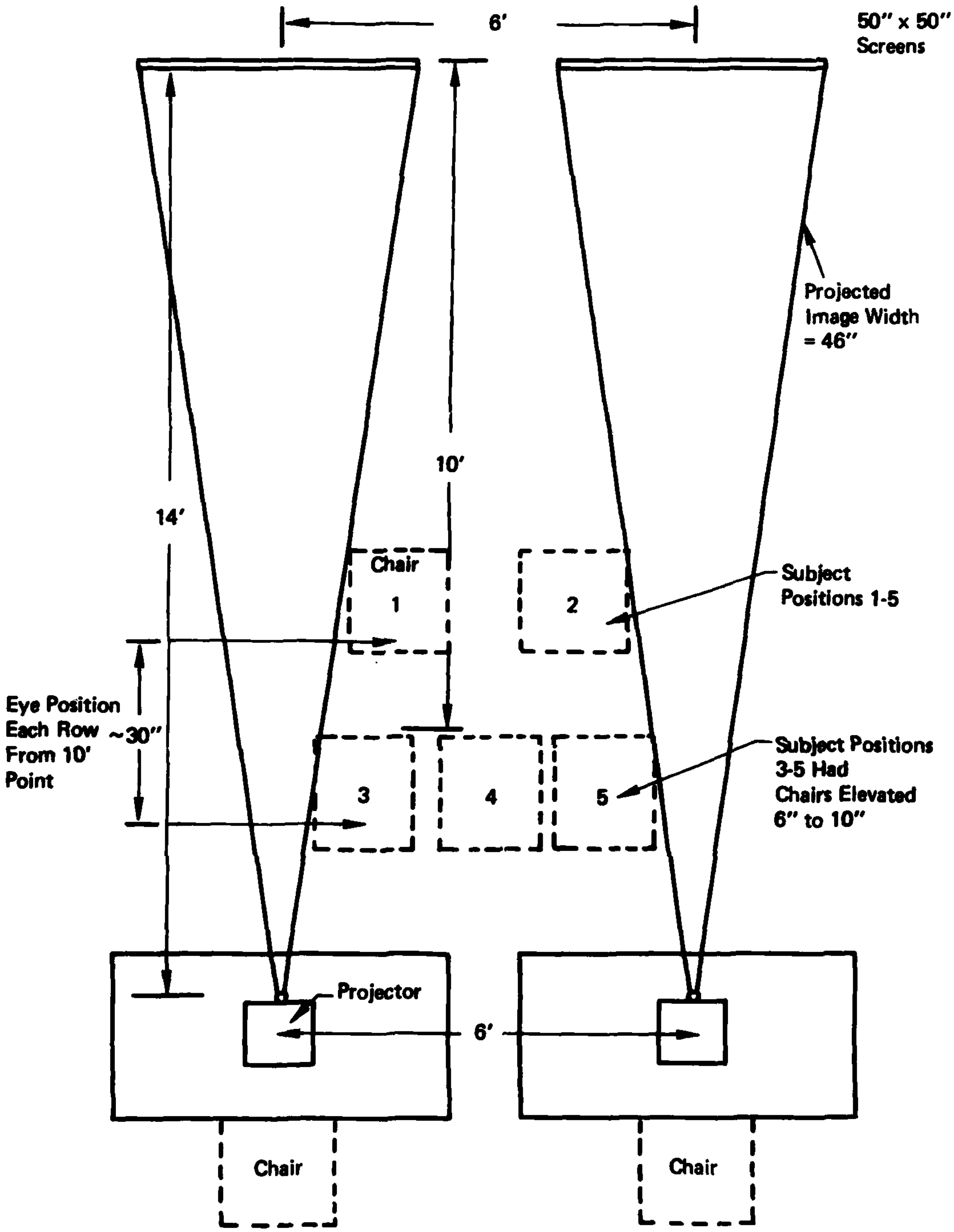

Figure A-2: Room Arrangement for Complexity Study

TABLE A-4. DATA COLLECTION SCHEDULE FOR COMPLEXITY AND AMBIGUITY STUDIES

Date	Location	Complexity Study No. of Subjects	Ambiguity Study No. of Subjects
15-19 Oct 73	Whidbey NAS	25	25
29 Oct-2 Nov 73	El Toro MCAS	25	25
12-16 Nov 73	Ft. Rucker AAF	25	25
26 Nov-1 Dec 73	George AFB	25	25

(b) Procedures. Subjects participated in the study in groups of five. Upon arrival at the test room, each group of subjects received tape recorded instructions, augmented with slides, outlining the purpose of the program and experimental procedures. A complete copy of instructions is contained in Appendix 1 to this Annex. Subsequently, eight slide-pairs were presented to practice response procedures and to resolve uncertainties regarding the experimental tasks.

Then the actual test session with 325 slide-pairs was begun. To reduce fatigue and/or boredom effects a 10-minute break was given after each sub-set of 65 comparisons had been made (about every 11 minutes).

Each slide-pair was presented for 10 seconds. During this period the subject indicated (on individual answer sheets) in which of the two scenes he thought it would be easier to find and identify small tactical targets. Although each scene contained a target, no mention was made of this by the experimenters.

Total time to complete a test session for a group of five subjects was approximately two hours.

(c) Data Collected. The primary data collected in the Complexity Study consisted of tallies of the number of times each slide was selected by the subject as being "easier" for finding targets. This data base of 32,500 points served in the data analysis for scaling the "complexity" aspects of target-area clutter.

After all comparisons had been made, each subject completed a biographical data questionnaire (Appendix 2) and open-ended debriefing questions (Appendix 3).

d. Ambiguity Study.

(1) Design. Using slides of target approach areas identical to those used in the Complexity Study, 100 military flight crewmen were asked to judge how many "cues and potential target elements or sites" were contained in each scene presented. In order to have a representative spectrum of ground features continued in the target approach areas, 10 scenes were selected from each of the 26 approaches at equal increments between MAR and "on top" locations. Thus, 260 scenes were viewed by each subject, resulting in a total of 26,000 data points. Presentation order of the 260 scenes was randomized for each group of five subjects participating in one session.

(2) Subjects. The majority of the 100 subjects (95), representing all four military services, had been flight crewmen for no more than 10 years, while five subjects had been military flyers for 11 years or longer. Sixty-seven subjects had operational experience in fixed-wing aircraft only, 21 in helicopters only, and 12 had experience in both helicopters and fixed-wing aircraft. Eighty subjects had combat flight experience in Southeast Asia.

Military ranks represented were WO-1 through CWO-3 and 0-1 through 0-4.

Five subjects had no college education, 17 had some college, and 78 were college graduates, including 11 who had advanced degrees.

(3) Equipment and Materials. The equipment and materials used in the Ambiguity Study were essentially the same as those for the Complexity Study (see Sec.A.3.c.(3)) with the following exceptions. Only one slide projector was used in the Ambiguity Study. The discrete ranges depicted by each scene corresponded to 10 (rather than five) proportional increments of "maximum available range", i.e., 10 percent increments between 10 percent and 100 percent of this range inclusive.

Room and seating arrangements for this study are shown in Figure A-3.

(4) Conduct of the Study. This section describes the sequence of events during a typical experimental session and the data generated during the experiment.

(a) Schedule. The data collection phase of this study extended over the same period as shown in Table A-4 of Section A.3.c.(4). An independent, new sample of 25 subjects from each location participated in the Ambiugity Study. The Complexity Study was

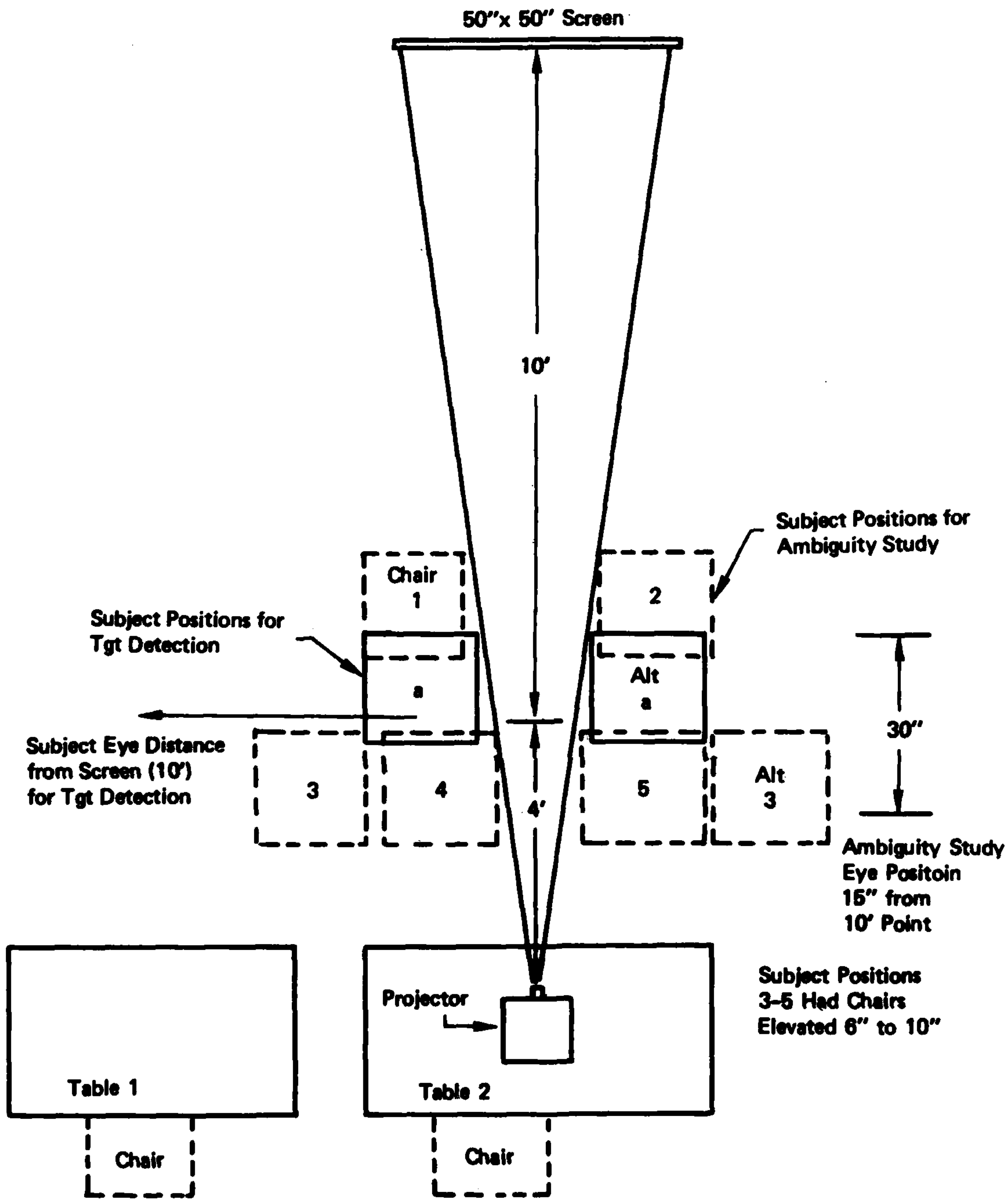

Figure A-3 : Room Arrangements For Ambiguity and Static Detection Studies

conducted in morning sessions and the Ambiguity Study was run in afternoon sessions.

(b) Procedures. Subjects participated in the Ambiguity Study in groups of five.

Upon arrival at the test room, each group of subjects received instructions as described in Section A.3.c.(4). Complete instructions are contained in Appendix 1. Then a "pretest" session was conducted in which the subjects were "walked through" a sample slide and given a chance to practice the procedures using four more slides. Pretest slides were not taken from the set used for testing.

During the test session each slide was presented for 12 seconds. The subjects were asked to count the things in the scene which looked enough like cues, potential target elements or sites to cause them to pause in their scanning of the scene for closer inspection. Each subject entered his count for each slide on his answer sheet. Although each scene contained a target, no mention of this was made to the subjects.

Three 10-minute breaks were taken during each session. Total time to complete a session for a group of five subjects was approximately 1 hour and 45 minutes.

(c) Data Collected. The primary data collected in the Ambiguity Study consisted of tallies of the numbers provided by the subjects for each target-approach area. The numbers serve as indicators of "clutter" by the relationship that the more "potential target elements" counted, the higher the target ambiguity, and, consequently, the area clutter.

Secondary data from the biographical and debriefing questionnaires was provided in the same form as that from the Complexity Study (see Sec. A.3.c.(4) (b)). Details are contained in Appendices 2 and 3.

e. Static Detection Study.

(1) Design. The Static Detection Study was designed to assess the time necessary for a representative sample of military flight crewmen to find and designate small tactical targets when searching statically presented target-area approach scenes. The scenes presented were identical to those used in the Ambiguity Study discussed above.

Each of the 26 targets was represented by a sequence of 10 slides beginning at MAR and closing at intervals of 0.1 MAR. For briefing and presentation purposes, the target sequences were arranged into the same six missions used in the Dynamic Imagery Experiment. The slide sequences representing the IA1 terrain table targets were added as the fifth targets in missions 3 and 6. The sequence of mission presentation for the 20 subjects corresponded with that for subjects 10 through 19 and 46 through 55 in the Dynamic Imagery Experiment.

The dependent variable was total elapsed time from first scene presentation to correct target designation.

(2) Subjects. Each of the 20 subjects, all Marines, had been a military flight crewman for 10 years or less. Twelve subjects had operational experience in fixed-wing aircraft only, four in helicopters only, and three had flown both helicopters and fixed-wing aircraft. Seven subjects had combat flight experience in Southeast

Ranks represented were CWO-2, O-2 and O-3. Sixteen subjects were college graduates and four had only some college.

(3) Equipment and Materials. In addition to the equipment and materials used in the Ambiguity Study (see Section A.3.d), the following items were used for the Static Detection Study:

- A timer for recording observer response times, activated initially by the experimenter and stopped by the subject when designating targets.
- A Kalcor Pointer Torch used by subjects to point to the items to which they responded in the scenes.
- One vertical and one oblique 8½" x 8 3/4" black and white reconnaissance photo of each target area.
- Verbal target descriptions.

Room and seating arrangement for this study are shown in Figure A-3.

(4) Conduct of the Study.

(a) Schedule. Data collection for this study extended from 7-11 Jan 1974.

(b) Subjects reported to the test room two at a time. Both were given a general introduction to program objectives, experiment instructions, and a practice session briefing. Then the subjects participated one at a time in the practice session, in which two unique target approaches with 10 different ranges each were used.

Subjects briefed for one mission at a time (with four or five targets per mission) by studying the verbal descriptions and photos provided. The two subjects alternated between briefing and test sessions, so that while one subject was being tested, the other was briefing for his next mission.

During the test sessions, the subject viewed the target approach scenes, which were changed to the next closer range every eight seconds by an automatic timer, until he thought he had detected the target. To signal detection, he pressed an "acquisition" button which "froze" the scene and stopped the automatic timer. He then used the hand-held light pointer to identify the scene element to which he had responded. The experimenter recorded the accuracy and length of time to the response and then restarted the timer. This procedure was repeated for each of the 10 scenes in each of the four or five targets in each of the six missions.

Total time to complete a session for a group of two subjects was approximately three hours.

(c) Data Collected. The primary data collected in the Static Detection Study consisted of the total time taken by each of the 20 subjects to correctly detect each of the 26 targets.

Secondary data was obtained from the biographical questionnaires. These are discussed in Appendix 2.

f. Physical Target and Scene Measures. A number of spatial and brightness measures was taken on the photography representing each of the 24 SEEKVAL IA2 target encounters. These measurements were taken from the slides used in the Complexity, Ambiguity and Static Detection Studies. Table A-5 lists the targets and indicates the target arrays and elements measured.

(1) Target Angular Subtense. Each of the 24 targets was measured from a projected image on a flat screen. The projection geometry was the same as that used in the static studies just discussed and depicted in Figure A-4. The four measures taken were:

TABLE A-5 GROSS TARGET CHARACTERISTICS

TARGET CODE	TARGET TYPE	TARGET AREA TYPE	TARGET-BACKGROUND COLOR CONTRAST	OUTSTANDING TARGET FEATURES	OUTSTANDING FEATURE COLOR CONTRAST
1-1	Medium anti-aircraft battery	Clearing in forested area	Dark olive drab on light tan	Revetment ground* scars	Light tan on brown
1-2	Howitzer battery (152mm), Self-Propelled	Clearing in forested area	Dark olive drab on light tan	Revetment ground* scars	Light tan on brown
1-3	Pontoon bridge	River, road, bridge	Light grey on river brown	Bridge - road* approaches	Light grey on light tan
1-4	Howitzer battery (122mm), towed	Clearing with scattered trees in forested area	Dark olive drab* on light brown	Vehicle track pattern	Tan on brown and dark green
2-1	Vehicle park	Large clearing	Dark olive drab on light brown	Vehicle track* pattern	Light tan on brown
2-2	POL storage area	Stacked drums along road	Olive drab on* light brown	2 rows-stacked drums along road	Olive drab on light brown and light tan
2-3	Howitzer Battery (203mm), Self-Propelled	Open area along road	Olive drab on light tan	Revetment ground scars	Light tan on green-brown

* Feature used for luminance measures.

TABLE A-5 GROSS TARGET CHARACTERISTICS

TARGET CODE	TARGET TYPE	TARGET AREA TYPE	TARGET-BACKGROUND COLOR CONTRAST	OUTSTANDING TARGET FEATURES	OUTSTANDING FEATURE COLOR CONTRAST
2-4	Helicopter pad	Clearing in light to medium forested area	Olive drab on green	Two helicopters*	Olive drab on green
3-1	Revetted tank platoon	Open field	Olive drab on light tan	Revetment* ground scars	Light tan on light green and brown
3-2	Antitank gun battery, towed	Clearing in forested area	Olive drab on light brown	Revetment ground* scar	Light brown on green
3-3	Surface to surface missile site	Open field	Olive drab on* green	Vehicles and track pattern	Olive drab on green, tan on green
3-4	SAM site	Clearing on hill in forested area	White on dark* green	White missiles on launchers	White on dark green
4-1	Tank convoy	Highway with shoulder parking	Dark olive drab* on light reddish tan	5 tanks, in-line	Dark olive drab on light reddish tan
4-2	Vehicle park	Clearing with scattered trees adjacent to highway	Dark olive drab* on green	Numerous parked trucks with track pattern	Dark olive drab on green

* Feature used for luminance measures.

TABLE A-5 GROSS TARGET CHARACTERISTICS

TARGET CODE	TARGET TYPE	TARGET AREA TYPE	TARGET-BACKGROUND COLOR CONTRAST	OUTSTANDING TARGET FEATURES	OUTSTANDING FEATURE COLOR CONTRAST
4-3	SAM site	Clearing in forested area	White on green and light tan	White missiles* on launchers	White on dark green
4-4	Antiaircraft machine gun site	Open field with scattered trees	Olive drab on light tan	Revetment* ground scars	Light tan on light brown/green
5-1	Antiaircraft battery (57mm) towed	Clearing with scattered trees adjacent to highway	Dark olive drab on light brown	Revetment* ground scars	Light brown on green
5-2	SAM convoy	Highway, open field	White on brown* and green	3 missiles/transporters in-line along highway	White on brown and green
5-3	Truck convoy	Highway scattered trees and adjacent open areas	Dark olive drab*	7 vehicles in-line along highway	Dark olive drab on green
5-4	Antiaircraft machine gun site (50mm)	Open field at road intersection	Very dark olive drab on dark brown and green	Clover leaf* pattern revetment	Grey/brown on dark green
8-1	SAM convoy	Open area-between highway and RR tracks	White on brownish* green	3 missiles on transporters in-line along highway and railroad	White on brown/green

*Feature used for luminance measures.

TABLE A-5 GROSS TARGET CHARACTERISTICS

TARGET CODE	TARGET TYPE	TARGET AREA TYPE	TARGET-BACKGROUND COLOR CONTRAST	OUTSTANDING TARGET FEATURES	OUTSTANDING FEATURE COLOR CONTRAST
6-2	Antiaircraft machine gun site (37mm)	Open area at road intersection	Very dark olive drab on light brown	Triangle shaped* revetment ground scars	Light brown on green
6-3	Tank convoy	Open area between highway & rail-road tracks	Dark olive drab* on light brown	5 tanks in-line along highway	Dark olive drab on light brown
6-4	Vehicle park	Open area adja-cent to highway	Olive drab on* green	Numerous parked vehicles and track pattern	Olive drab on green
$\tilde{T}$	Tank platoon, (low clutter-terrain table)	Open area with road to river approach	Light olive drab* on light green	3 tanks-side-by-side	Light olive drab on light green
T	Tank platoon (high clutter-terrain table)	Open area with numerous scat-tered trees with road to river approach	Light olive drab* on light green	3 tanks-side-by-side	Light olive drab on light green

*Feature used luminance measures

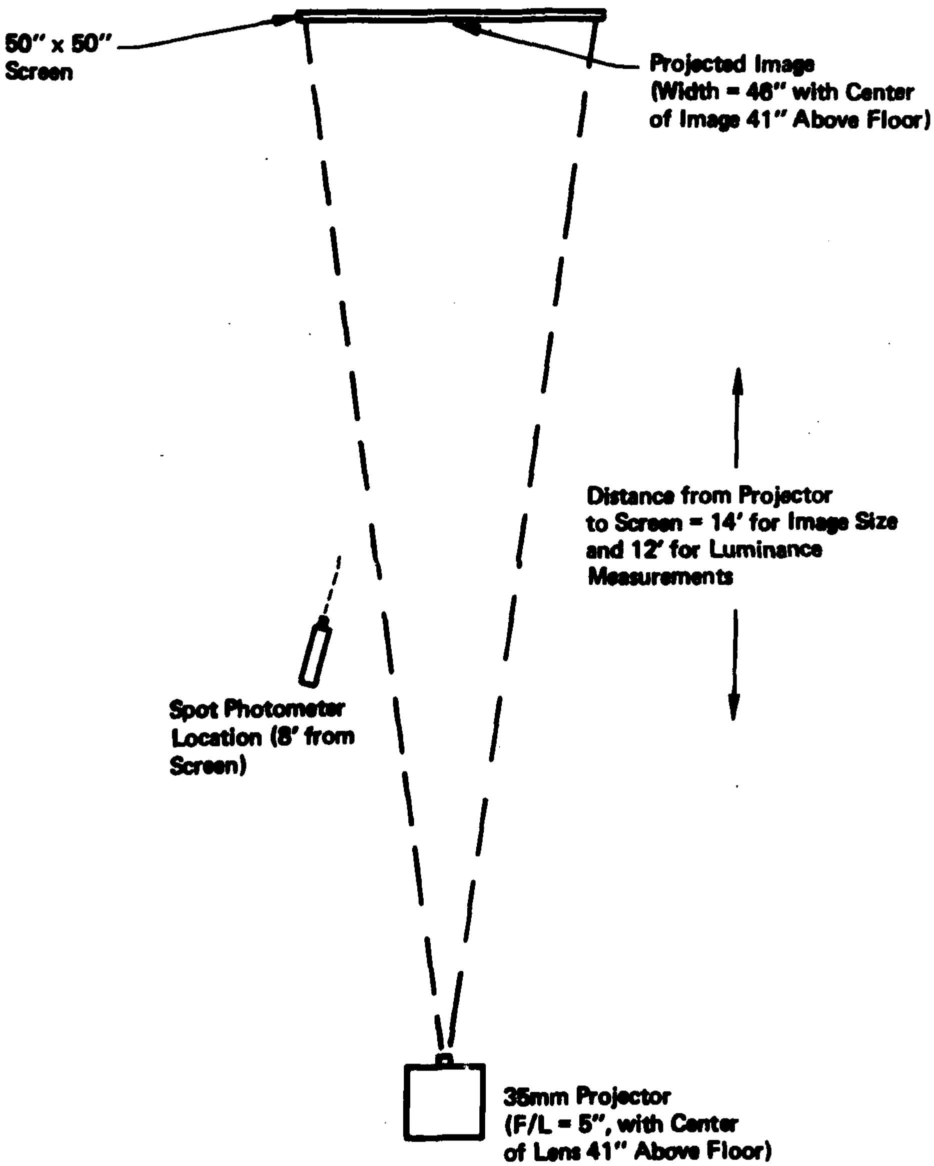

Figure A-4: Physical Measures Equipment Layout

- Major dimension of the target array. This is the longest dimension of the immediate target area and included associated revetments, ground scars and track patterns.

- Minor dimension of the target array. This is normal to the major dimension of the projected image.

- Major dimension of a representative target element. Example target elements are a truck in a truck park, a missile in a SAM site and a single gun in an antiaircraft artillery site.

- Minor dimensions of the representative target element.

In order to standardize the measurements across targets, measures were taken on the two scenes nearest the standard range and interpolated. For the array measures, the standard range was 3000 feet, because this was considered to be close to expected acquisition range. One thousand feet was selected for the target element measures in order to get better detail resolution. These ranges were arbitrarily selected and as long as their values were standardized across targets, the absolute ranges were unimportant.

The measurements were taken in feet and converted to milliradians of visual angle (B) at an observer's eye located 10 feet from the screen. The conversion formula is given by:

$$B = 2 \arctan \frac{e}{2R}$$

where e = Screen measurement (feet), and

R = Screen-to-observer distance (10 feet).

(2) Light Measures. Target and background luminances were measured from projected images of the slides closest to 1000 feet from each of the 24 targets. Background luminance was the average of several readings from the immediate target area and target luminance was measured on a representative target element.

A Gamma Scientific Model 700 Log-linear Photometer was equipped with a Model 700-6 precision photometric telescope whose f 2.8 lens gave it a focal range from six minutes to infinity. A probe attachment on the telescope yielded a spot size of six minutes of arc. The equipment was calibrated with a GPL Precision 1000 Standard light source with power supplied from a Gamma Scientific Model 220-1 power supply and luminance standard head.

Contrast values were calculated using the expression:

$$C = \frac{L_T - L_B}{L_B}$$

where C = Contrast,

L_T = Target Luminance, and

L_B = Background Luminance.

(3) Target Visual Availability. In order to define the range interval along the flight path in which a correct acquisition response can occur, a measure of the target's visual availability is required. The measure, called visual maximum available range (MAR) was obtained in cataloging the mission films of the Dynamic Imagery Experiment for target content and availability.

To calculate MAR, a total of three frame number events were recorded for each target encounter. Single frame viewing was used to establish the point where the target passed minimum viewing range (45^{o} field-of-view downangle), and the point in maximum range where the target was first discriminable in the display. The latter estimate made use of a modified method-of-limits procedure to determine the transmition point of target availability in both receding and approach directions. The minimum viewing frame was then used as a basis for calculating the "zero" horizontal range frame number (aircraft directly over or abeam the target). Using the film sequence itself as a base line, indicated frame number relationships may then be converted into ground ranges as required based on the number of ground feet covered per frame of film.

The mathematical computation is described by:

MAR = (Zero frame no. - Target first discriminable frame no.)

X (Ground feet covered per frame of film)

The frame cataloging procedure, and associated calculations, accounts for aircraft altitude, lens geometry, camera viewing angles and angular target position in the field-of-view.

For each target the point of first discriminability was determined in the following manner: An experienced observer viewed the target on the simulator screen, then backed the film in the projector until the last target element disappeared. He noted the film frame number at this point then repeated the measurement several times in both forward and backward direction. Three independent experimenters did this and the median value was taken as the point of first discriminability. These human observers were used to calibrate characteristics of the filmed scenes. Thus, MAR contains target availability characteristics due to atmospheric attenuation existing at the time of filming as well as attenuation due to optical characteristics of the taking camera, the film, and the simulator projection system.

4. RESULTS AND DISCUSSION

a. Dynamic Imagery Experiment.

(1) Data Treatment. The events occurring in any one target encounter are summarized in Figure A-5. The probability tree at the left of this figure is referenced to the range continuum at the right. At the first level, the subject either acquired the correct target or target area with probability p(correct) or he missed it with probability p(miss). Secondly, if there was an acquisition, it occurred either before the predetermined maximum available range (MAR) with p(premature) or between MAR and the target. The premature acquisitions (those before MAR) appeared to be responses to the correct target area before the target itself was visible.

In addition, the subject could "acquire" the wrong target. This event was always followed by one of the three events just listed. Therefore the total number of misses, acquisitions before MAR, and acquisitions after MAR was 1728, the number of trials in the study.

Ground range from the acquisition point to the target was determined for correct responses. The film frame number of each acquisition was subtracted from the predetermined "on top" frame number for that target and the result was converted to ground range in feet. These ranges constitute the basic data from the Dynamic Imagery Experiment.

But two questions arise: If we want the range measure to completely describe acquisition performance, missed targets and premature responses should be somehow included. If we include missed targets, the extreme case could arise where one subject acquired a target at long range and all the other subjects missed it. Then the mean acquisition range would be long on a very difficult target.

Also, operational pilots frequently convert to attack when they see the target area, but for purposes of this study the subjects were asked to wait until they saw the target itself. This was done to assess acquisition performance on the small tactical targets used here. Sometimes the subjects reverted to old habits and made area responses. When this occurred, it was scored as a premature response. In treatment of the range data, these responses were excluded. The only deviation from this was in the analyses of variance where, due to the requirement for equal cell size, the ranges of premature responses were replaced by the mean range for correct acquisition of that target under that condition.

In order to most completely describe these events, the basic performance metric for this experiment was taken to be the mean range of

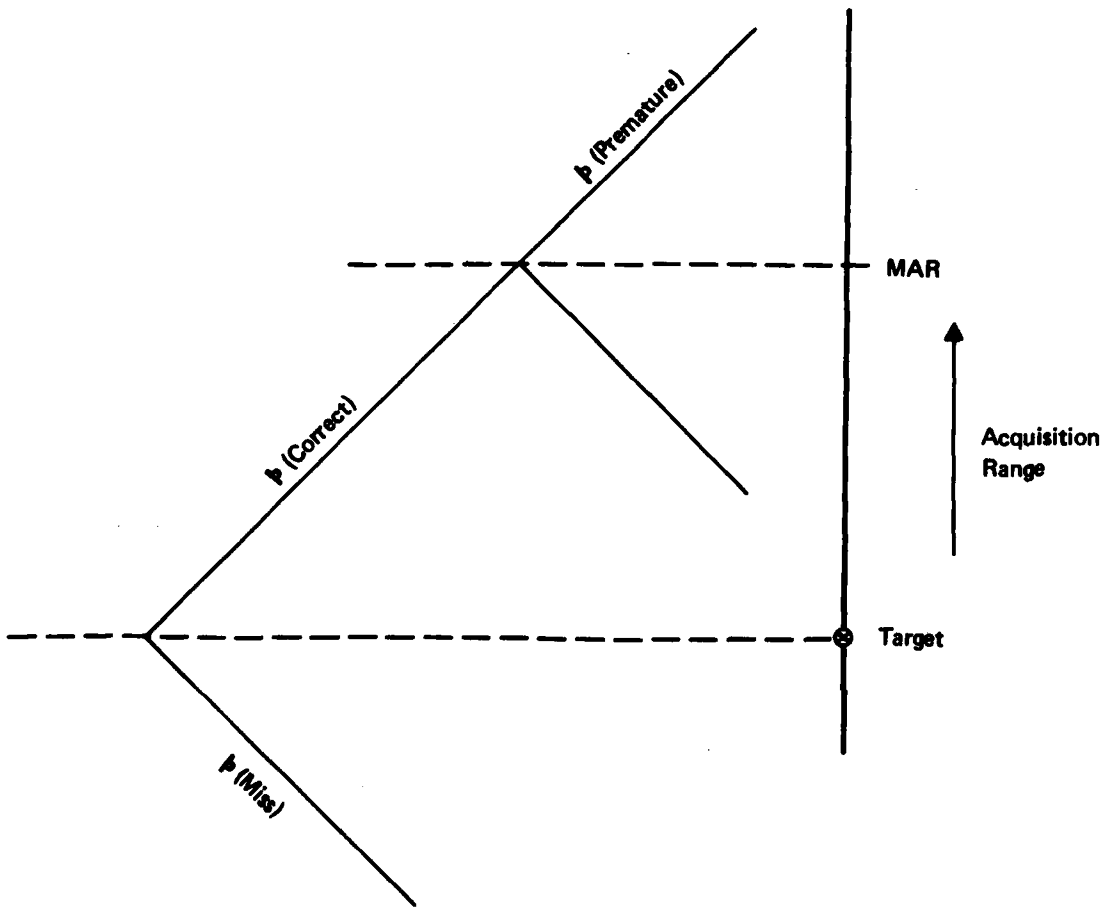

Figure A-5: Probability Tree and Range Continuum Describing Events Occurring in a Target Encounter

acquisitions between MAR and the target ($\bar{R}$), weighted by p (correct). These scores will be termed "weighted mean acquisition ranges" (ACQR). Thus:

$$ACQR = p\ (correct) \times \bar{R}.$$

For a single measure of acquisition preformance, ACQR appears to be the most efficient and logical metric. It includes both R and p (correct) data in a straight forward manner and use of ACQR precludes logical error. That is, if one observer acquired a target at long range and the others missed it, R would show the target to be easy but ACQR would correctly reflect its difficult nature.

It has been frequently noted, e.g., Reference 3, that MAR is one of the strongest predictors of acquisition range. That is, targets which can be seen at relatively long ranges will be acquired at long ranges relative to the other targets. Converting range data to a composite index which includes MAR should have the effect of increasing the variance due to the other independent variables. A new metric called "search performance ratio" (SPR) has been defined to express this:

$$SPR = (MAR-R)/MAR = 1-(R/MAR)$$

where R = acquisition range, and

MAR = maximum available range.

SPR will vary from 0.0 for an acquisition made at MAR to 1.0 for an acquisition at zero range. The name "search performance ratio" comes from the interpretation that this is the proportion of MAR used in search before acquisition.

Although SPR has this interesting theoretical interpretation, a more straight-forward analysis results from using weighted mean acquisition range (ACQR) as the primary independent variable fro[illegible] experiment. Therefore, while SPR is given some statistical treatment [illegible], ACQR was the output from this study selected as the independent variabl[illegible] in the regression analysis.

Cumulative probability ogives appear in this section and in Appendix 4 to this Annex. In these curves, cumulative probability to target acquisition is plotted as a function of ground range in the following manner. The acquisition distances (R) of each data point to be included in the curve are ordered such that $R_i < R_i+1$, $(i = 1,n)$ where n is the number of data points in the set. A cumulative acquisition probability (p) is assigned to each R_i by the relationship $p_i = i/n$. This probability is then converted to a standard z score from a table of the cumulative normal distribution function. A quadratic function, $z = a + bR + cR^2$, is fit by the method of least-squares to this ordered set of z_i, R_i points. The best fit quadratic function is then transformed to linear probability space by converting the z values of the curve at appropriate range intervals to corresponding probability values of the cumulative normal

distribution function. Misses are included in this operation as zero range so the resulting curves peak at p(correct). Use of this procedure results in a smooth curve which has been shown to provide a good fit of cumulative frequency data, even if it represents a non-normal distribution (References 3 and 4).

Figure A-6 summarizes the probability and acquisition range main effects. The lower subfigure represents proportion of errors and the higher subfigure shows weighted mean acquisition range. Statistically significant main effects are indicated by S. The .05 criterion level was selected and a variety of statistical tests were calculated as discussed in the following paragraphs.

(2) Cueing Effect. The effect of inflight cueing was studied here by comparing acquisition performance with FAC assistance and the range-to-go device with a control condition where neither was used. The low briefing level was used under these conditions and missions were flown at 360 knots.

Proportion of missed targets, p(miss), was .17 with range-to-go, .10 with the FAC and .17 with no cueing. By the Chi-square statistic, the difference between FAC and no cueing was significant ($p < .02$). FAC assistance, then, increased correct acquisition by 7 percent in this study.

The proportion of incorrect acquisition response was .07 with range-to-go, .06 with the FAC and .10 with neither. The differences were not statistically significant. In general, these errors are relatively infrequent and distributed fairly evenly across targets.

The same is true of premature responses where p(premature) was .04 with range-to-go, .05 with the FAC and .03 with neither. Again, the differences were not significant.

Weighted mean acquisition range was 2491 feet with the range-to-go indicator, 2992 feet with the FAC and 2391 feet with neither. Table A-6, which summarizes the cueing analyses of variance, shows the cueing effect on acquisition range to be highly significant. Dunnett's test showed the difference between the range-to-go and control condition was not significant. Mean SPR for the range-to-go condition was .6088, for the FAC condition .5314 and for the control condition .6199. Again, the analysis showed this effect to be signigicant. Here, Dunnett's test showed that the difference between the FAC and the control condition was significant ($p < .005$) but the difference between range-to-go and control was not. A more complete discussion of Dunnett's test is given by Winer (1962), cited in the Statistical Bibliography of this report.

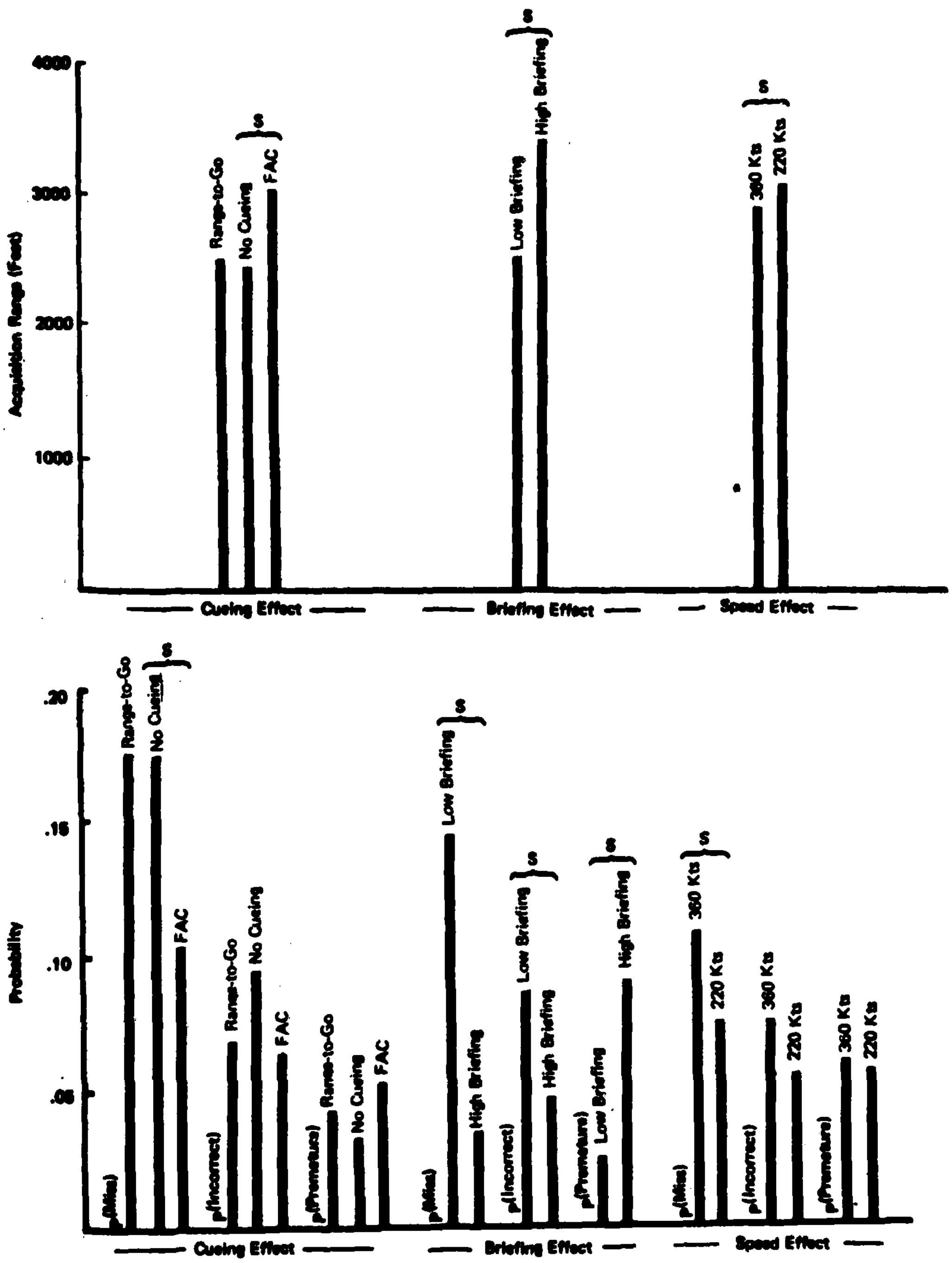

Figure A-6. Probability Data and Mean Acquisition Ranges for the Main Effects in the Dynamic Imagery Experiment

TABLE A-6. ANALYSIS OF VARIANCE SUMMARY - CUEING EFFECT

SOURCE	ERROR TERM	DEGREES OF FREEDOM	MEAN SQUARES (ACQUISITION RANGE)	F-RATIO (ACQUISITION RANGE)	MEAN SQUARES (SPR)	F-RATIO (SPR)	"F" REQUIRED FOR $p < 0.05$
Cueing - C	S(CMT)	2	2.983×10^7	17.499	0.669	15.068	3.00
Missions-M	T(M)	5	4.809×10^7	0.770	1.332	2.649	2.77
Targets Within Mission-T(M)	S(CMT)	18	6.247×10^7	36.648	0.503	11.321	1.67
Cueing by Mission-CM	CT(M)	10	3.711×10^6	1.566	0.106	1.952	2.16
Cueing by Target Within Mission CT(M)	S(CMT)	36	2.371×10^6	1.391	0.054	1.220	1.46
Subjects Within Conditions Missions & Targets S(CMT)	--	792	1.704×10^6	--	0.044	--	--

The structural model for this analysis is

$$X_{ijkl} = X.... + C_{i} + M_j + T_{k(j)} + CM_{ij} + CT_{ik(j)} + S_{l(ijk)}$$

where X.... is the grand mean and parenthetical subscripts denote nesting relationships.

Figure A-7 shows a summary of target acquisition performance in the three conditions defining the cueing effect in this study. The cumulative probability curves in this figure are taken across targets, missions and subjects. The shaded area at the left represents ranges beyond MAR in which the targets are not visually available. Superior performance in the FAC condition is clearly shown by its longer acquisition range and higher final probability of acquisition.

Subjective information obtained from the subjects and summarized in Appendix 3, Tab A reinforces the performance data. Immediately after the flight with the FAC, this cueing aid was rated most often by the subjects as the most useful of all the briefing and inflight aids available in that condition. Some subjects commented that the FAC was inappropriate for the mission profile flown in this test. However, the majority of the subjects considered the FAC helpful both in early search for the target area and in positive identification of the target itself. It may be that the FAC helped here by confirming the subjects' suspicions on the target location. In this way, effective search area might have been reduced to the area where the pilot -- and the FAC -- thought the target was.

Again confirming the performance data, subjects found the range-to-go indicator to be the least useful of all the aids provided. Over one-third of the subjects said they ignored it completely. The subjects' lack of familiarity with this type of indicator appears to be the most likely reason for its failure as an aid in the target acquisition. Most of the subjects were accustomed to thinking in terms of time-to-go rather than range-to-go as their pacing dimension.

(3) Briefing and Speed Effects. Four of the six conditions in this study dealt with assessment of speed and briefing effects. Table A-7 summarizes the resulting performance measures. Combining these measures across speed shows the briefing effects and combining across briefing level shows the speed effects.

Comparing briefing levels, we see that with the high briefing level, p(miss) and p(incorrect) were both lower and p(premature) was higher than with the low briefing level. These effects were all significant ($p < .01$). Weighted mean acquisition range was longer and mean SPR lower with the high briefing level. The analysis of variance summary given in Table A-8 shows both of these effects to be highly significant. No significant speed by briefing interaction was found. The only significant briefing interaction was briefing by targets within mission.

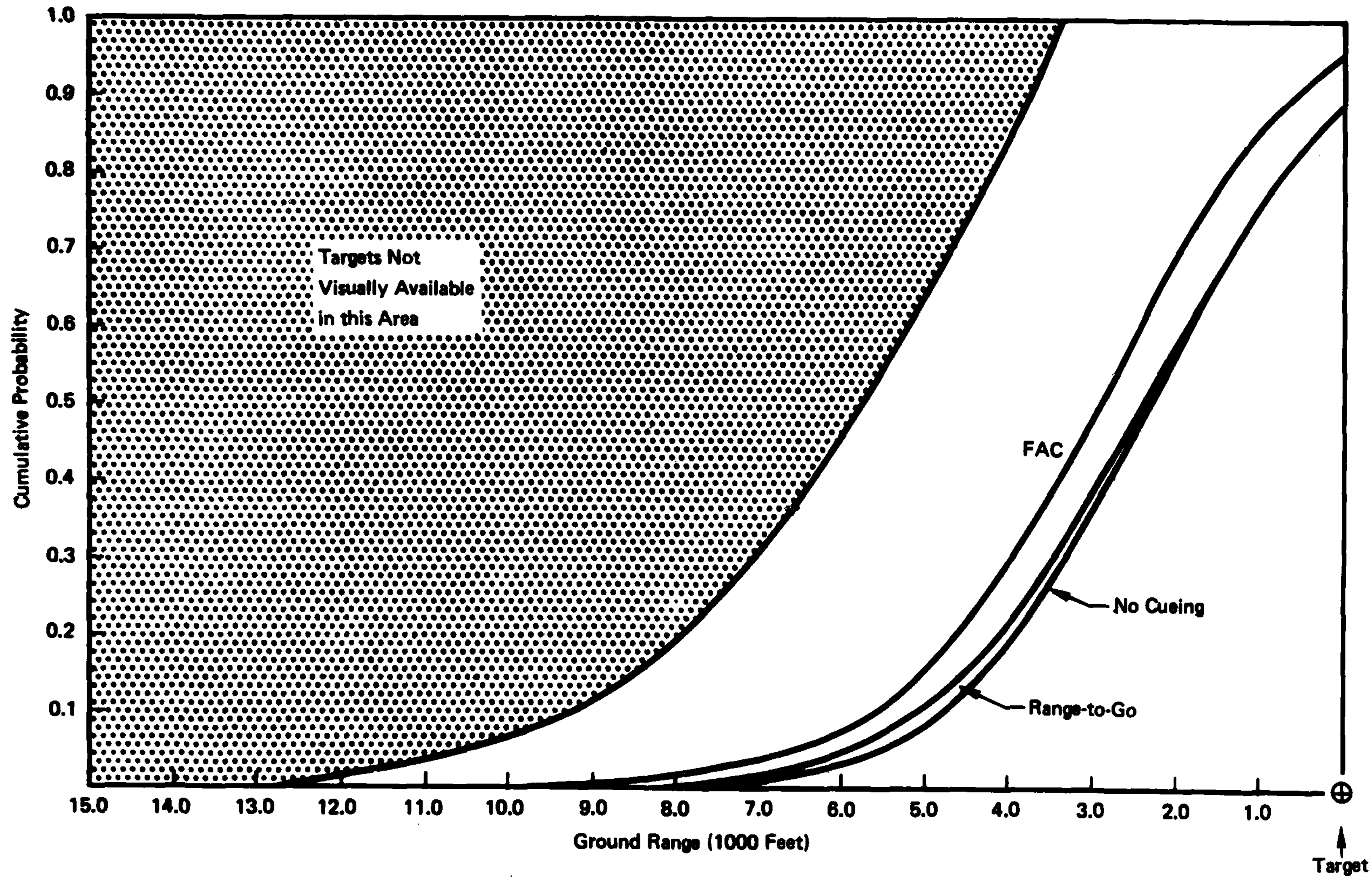

Figure A-7: Probability of Acquisition as a Function of Range for the Three Cueing Conditions

TABLE A-7. PERFORMANCE MEASURES FOR SPEED AND BRIEFING LEVEL COMPARISONS

MEASURE		220 KNOTS	360 KNOTS	COMBINED ACROSS SPEEDS
High Briefing Level	p(miss)	.031	.042	.036
	p(incorrect)	.038	.056	.047
	p(premature)	.094	.087	.090
	Range (feet)	3498	3292	3395
	SPR	.429	.461	.445
Low Briefing Level	p(miss)	.118	.174	.146
	p(incorrect)	.076	.097	.087
	p(premature)	.021	.031	.026
	Range (feet)	2574	2391	2482
	SPR	.586	.620	.603
Combined Across Briefing Levels	p(miss)	.075	.108	
	p(incorrect)	.057	.077	
	p(premature)	.057	.059	
	Range (feet)	3036	2841	
	SPR	.508	.540	

TABLE A-8. ANALYSIS OF VARIANCE SUMMARY - BRIEFING AND SPEED EFFECTS

SOURCE	ERROR TERM	DEGREES OF FREEDOM	MEAN SQUARES (ACQUISITION RANGE)	F-RATIO (ACQUISITION RANGE)	MEAN SQUARES (SPR)	F-RATIO (SPR)	"F" REQUIRED FOR $p < 0.05$
Briefing-B	S(BVMT)	1	2.398×10^8	172.359	7.226	188.168	3.84
Speed-V	S(BVMT)	1	1.093×10^7	7.853	.310	8.071	3.84
Missions-M	T(M)	5	7.031×10^7	.991	1.338	3.137	2.77
Targets Within Mission-T(M)	S(BVMT)	18	7.094×10^7	50.979	.426	11.107	1.67
Briefing by Speed -BV	S(BVMT)	1	4.006×10^4	.029	.002	.059	3.84
Briefing by Mission-BM	BT(M)	5	3.709×10^6	.880	.109	.638	2.77
Speed by Mission-VM	VT(M)	5	2.876×10^6	2.974	.052	1.818	2.77
Briefing by Target Within Mission-BT(M)	S(BVMT)	18	4.214×10^6	3.028	.171	4.457	1.67
Speed by Target Within Mission-VT(M)	S(BVMT)	18	9.670×10^5	.695	.023	.589	1.67
Briefing by Speed by Mission-BVM	BVT(M)	5	9.362×10^5	.968	.021	.729	2.77
Briefing by Speed by Tgt Within Mission-BVT(M)	S(BVMT)	18	9.674×10^5	.695	.028	.743	1.67
Subjects within Conditions, Missions & Tgts-S(BVMT)	—	1056	1.391×10^6	—	.038	—	—

The structural model for this analysis is

$$X_{ijklm} = X..... + B_i + V_j + M_k + T_{l(k)} + BV_{ij} + BM_{ik} + VM_{jk} + BT_{il(k)} +$$

$$VT_{jl(k)} + BVM_{ijk} + BVT_{ijl(k)} + S_{m(ijkl)}$$

where X..... is the grand mean and parenthetical subscripts denote nesting relationships.

Figure A-8 summarizes the briefing effect. The upper curve is taken over Conditions 3 and 4 and the lower curve over Conditions 5 and 6. The separation in the curves clearly shows the superiority of the briefing level with respect to both acquisition range and p (correct).

Referring again to Table A-7, it can be seen that speed effects were generally weaker than those of briefing. A significantly ($p < .01$) higher proportion of targets were missed at 360 knots (p(miss)=.108) than at 220 knots (p(miss)=.075) but the differences in p(correct) and p(premature) were not significant. At 220 knots, weighted mean acquisition range was longer and SPR was shorter than at 360 knots; both these differences are statistically significant, but of relatively low magnitude. The cumulative probability curves in Figure A-9 show again the clear but numerically small differences in acquisition range and p(correct) between 220 and 360 knots.

The high briefing level differed from the low briefing level only by the additon of vertical and forward oblique photographs of each target. In the debriefing, most subjects agreed that the photos were by far the most useful of the aids available. Some subjects preferred the oblique photographs, an equal number found the vertical photos most useful, while the majority used both types of photos.

About two-thirds of the subjects said their performance was affected by mission airspeed. Forty-five of the 72 subjects found it was easier to search for targets at 220 knots than at 360 knots, and three subjects said it was harder at 220 knots. The remaining 24 reported no difference in their performance at the two speeds, possibly because as one observer hypothesized, the added search time at 220 knots was negated by trying to assimilate too much information during that time. In subjective opinion of the speed variable, differences among subject qualifications appeared. The helicopter pilots reported feeling rushed in searching for targets even at 220 knots, while some of the high performance jet pilots felt that 360 knots was uncomfortably slow and unrealistic for a threat environment.

(4) Subject and Target Effects. One of the specific objectives of this project was to determine the proportion of the total variance in target acquisition performance attributable to differences in subjects.

In a study using subjects as measuring instruments, the intent is always to minimize measurement error due to differences between subjects. The degree to which this intent is satisfied depends on the design and execution of the study and the strength of the independent variables.

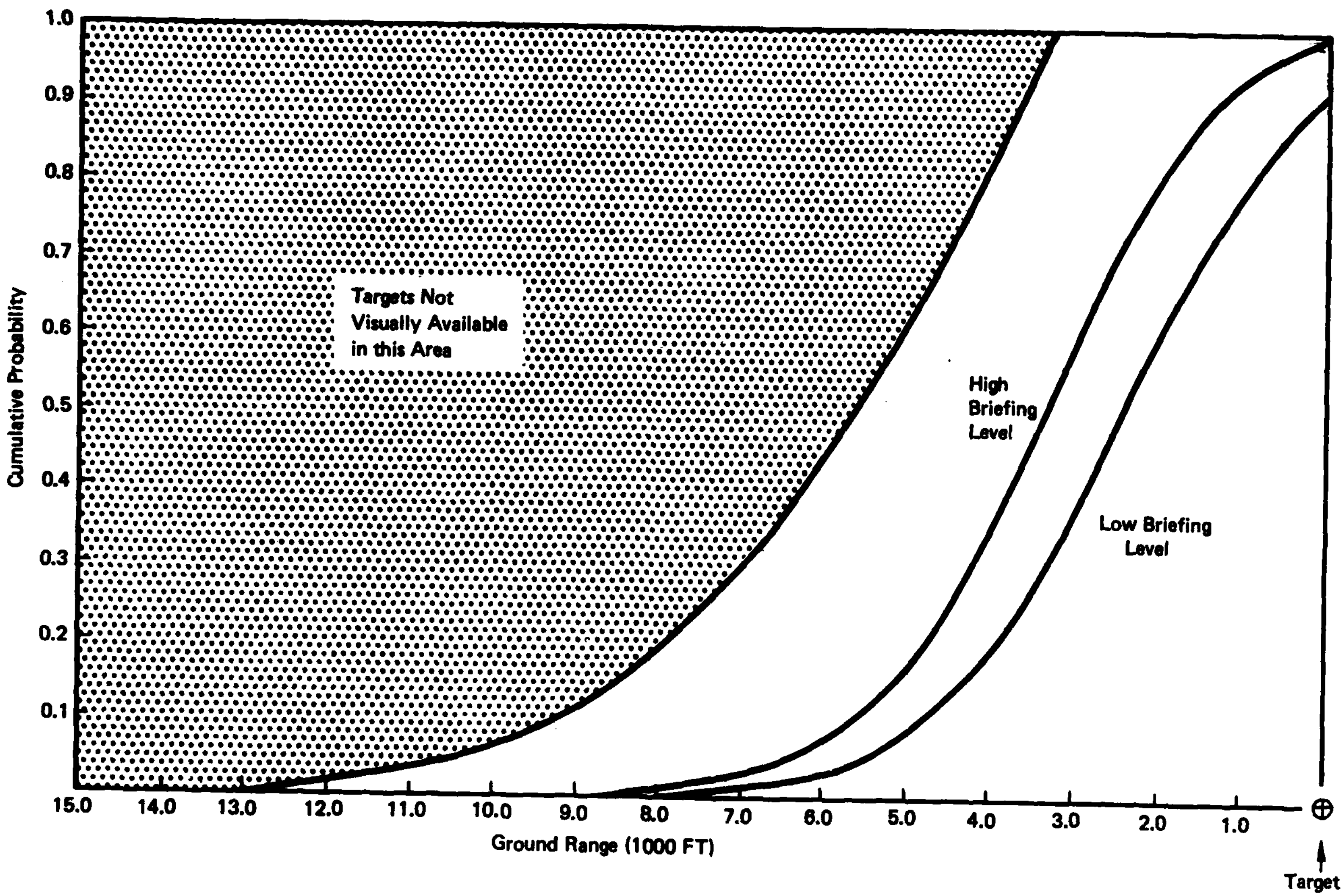

Figure A-8. Probability of Acquisition as a Function of Ground Range for the Low and High Briefing Level Conditions

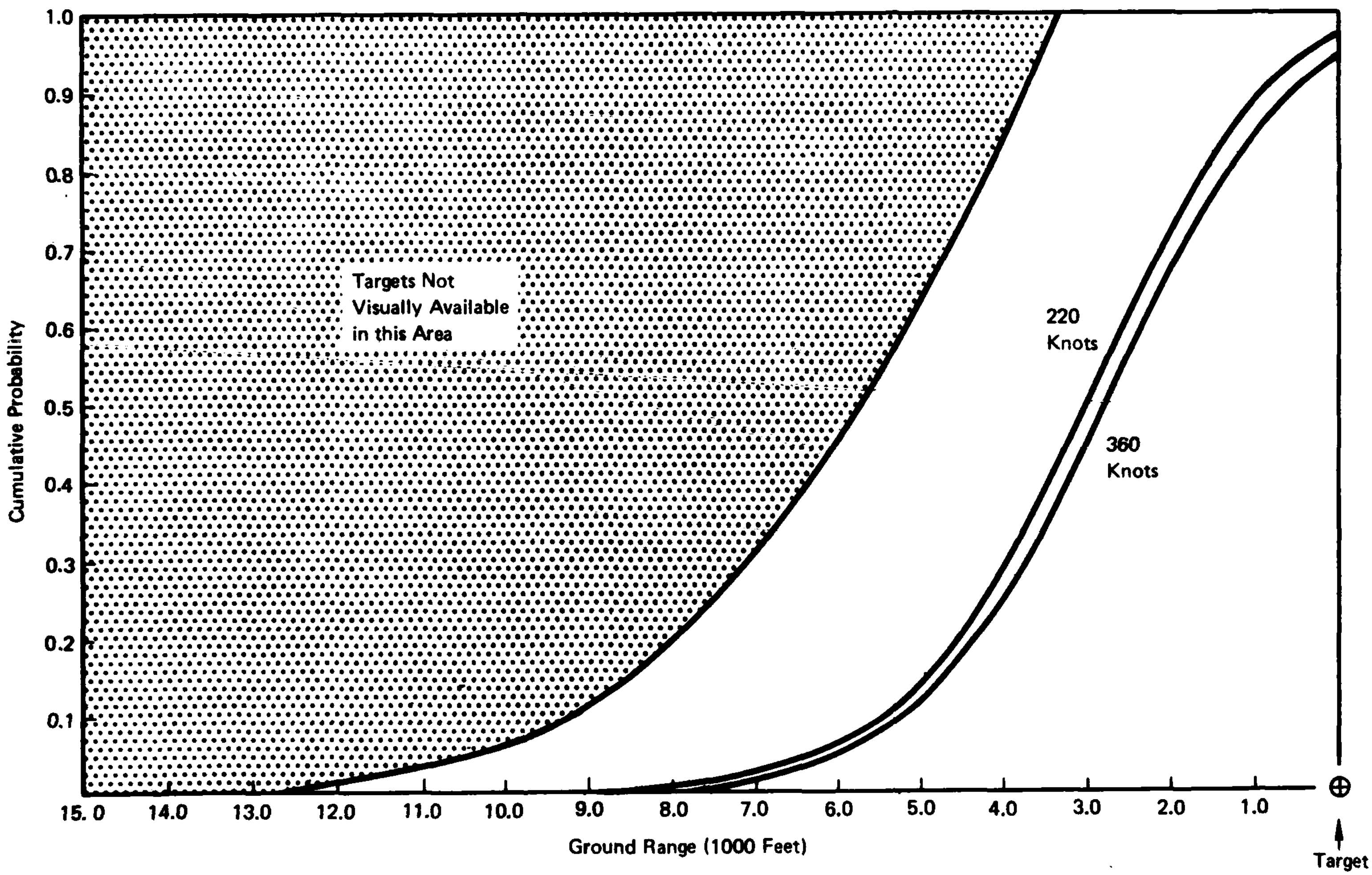

Figure A-9. Probability of Acquisition as a Function of Ground Range for the 220 and 360 Knot Conditions

The experimental design for the Dynamic Imagery Experiment was separated into two analyses of variance. In the first analysis, dealing with the cueing effects, the subjects contributed 1.15 percent of the total variance. The second analysis, on speed and briefing effects, showed that subjects contributed 0.34 percent of the total variance. The difference in subject contribution to total variance results from the fact that in the second analysis the briefing effect was so strong that it accounted for 58.9 percent of the variance, leaving that much less for the other variance components. These proportions were derived by dividing the mean square due to subjects and reported in Tables A-6 and A-8 by the totals of the mean squares in those analyses. The same method is used later in determining the amount of variance due to targets except that the missions and targets-within-missions mean squares were pooled to represent the target/background effect.

When using human subjects, the question always arises, "How many subjects should we use in each cell of the design?" The number of subjects depends on the desired precision of measurement. That is, if we consider a mean acquisition range difference of 200 feet to have operational utility, then we should use enough subjects to ensure that 200 foot differeences are statistically significant. In the present experiment, for example, the difference in weighted mean acquisition range due to speed was 195 feet, and this effect was significant at the 99 percent confidence level. The usual methods of determining required number of subjects to achieve a given degree of confidence for a given size difference require statistical independence among the samples. Here, the same subjects and the same targets appeared at both speeds, so statistical extrapolation is tenuous at best. It can be said though, that these results were obtained with 12 subjects per condition per mission, and invite the conclusion that 12 subjects are enough to provide statistical confidence in differences of this magnitude in studies with similar designs on a similar subject matter. For studies with different designs, the mean and variance from an appropriately selected cell of this study can be used as a starting place for sample size estimates.

The amount of variance due to main target effects was 74.6 percent in the cueing analysis of variance and 34.7 percent in the speed and briefing analysis. It is a common finding that target or target/background differences account for the lion's share of the variance. A major thrust of this project is to measure elements of that target background variance component and then integrate the resulting scales in a regression analysis. Sections A.4.c through A.4.f give the results of the scaling efforts and the regression analysis.

(5) Ancillary Hypothesis: Target Leveling. In a study on target acquisition with an infrared sensor simulation (Reference 5), it was found that visual cueing (circles around the targets) had a target leveling effect on acquisition performance. That is, acquisition of difficult targets was aided more than acquisition of the easier targets by the visual cueing. In the Dynamic Imagery Experiment, there were two places where this effect could have occurred. Since, in this experimental design, each mission contained four different targets, both the mission and the target within mission sources in the analyses of variance reflect variance due to targets.

In the cueing dimension, use of the FAC might have brought about a leveling effect. In Figure A-10, the 24 targets used in this study are ordered by weighted mean acquisition ranges obtained in the condition with no cueing. Then, weighted mean acquisition ranges were plotted for that condition and for the FAC condition. If the target leveling hypothesis were true here, the bar extensions for the FAC acquisition ranges would be longer on the right side than on the left. This clearly does not hold. It appears that the possible interaction is largely due to unusually large FAC facilitation on targets 6-3, 3-2, and 2-3 and to very slight facilitation, or even hindrance on some of the other targets.

Figure A-11 shows a similar test with respect to briefing level. Here the hypothesis was that the use of briefing photographs would serve to level performance across targets. There was a significant briefing by targets-within-mission interaction. Targets were ordered by weighted mean acquisition ranges in the low briefing level conditions and were plotted as bars for both the low and high briefing conditions. There is some indication of leveling, but a statistical test of the hypothesis failed.

b. Complexity Study

(1) Data Treatment. It will be recalled that, in the Complexity Study, 100 subjects were asked to judge in which member of each of 325 pairs of slides it would be easier to find a target. Each of the members of any pair represented a different target approach area, and pairs were constructed in such a way that each target approach area was paired with each of the other approach areas an equal number of times. The basic data from this study is the total number of "easier" judgments given each target approach area. These counts are presented in Figure A-12, organized by target and mission as used in the Dynamic Imagery Experiment. The two bars at the top of that figure are from the AMRL terrain table target approach area with (T) and without ($\bar{T}$) added trees in the scene.

As can be seen in Figure A-12, the modified paired comparisons technique used here resulted in excellent discrimination among the 26 target approach areas. Using this frequency data to obtain a rank ordering of "scene complexity" results in the target ranks shown in Table A-9 where it can be seen that the target-approach area of Target 6-2 was judged to be "least complex" while the target approach area of Target 3-4 was judged to be "most complex." The terrain table targets were judged consistent with *a priori* expectations, i.e., the target area without trees was judged significantly less complex than the target-area with trees.

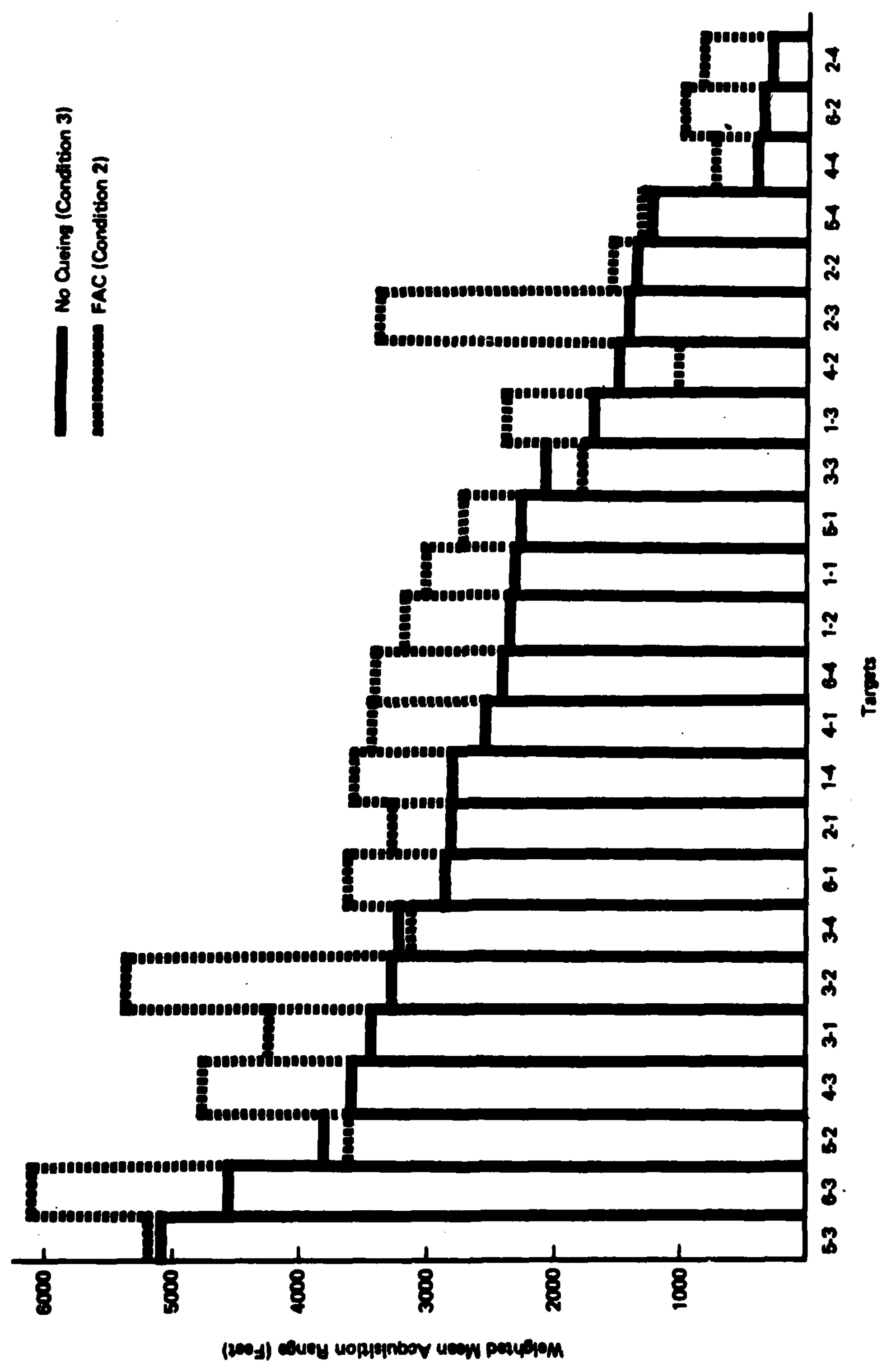

Figure A-10. Weighted Mean Acquisition Ranges With and Without FAC Cueing

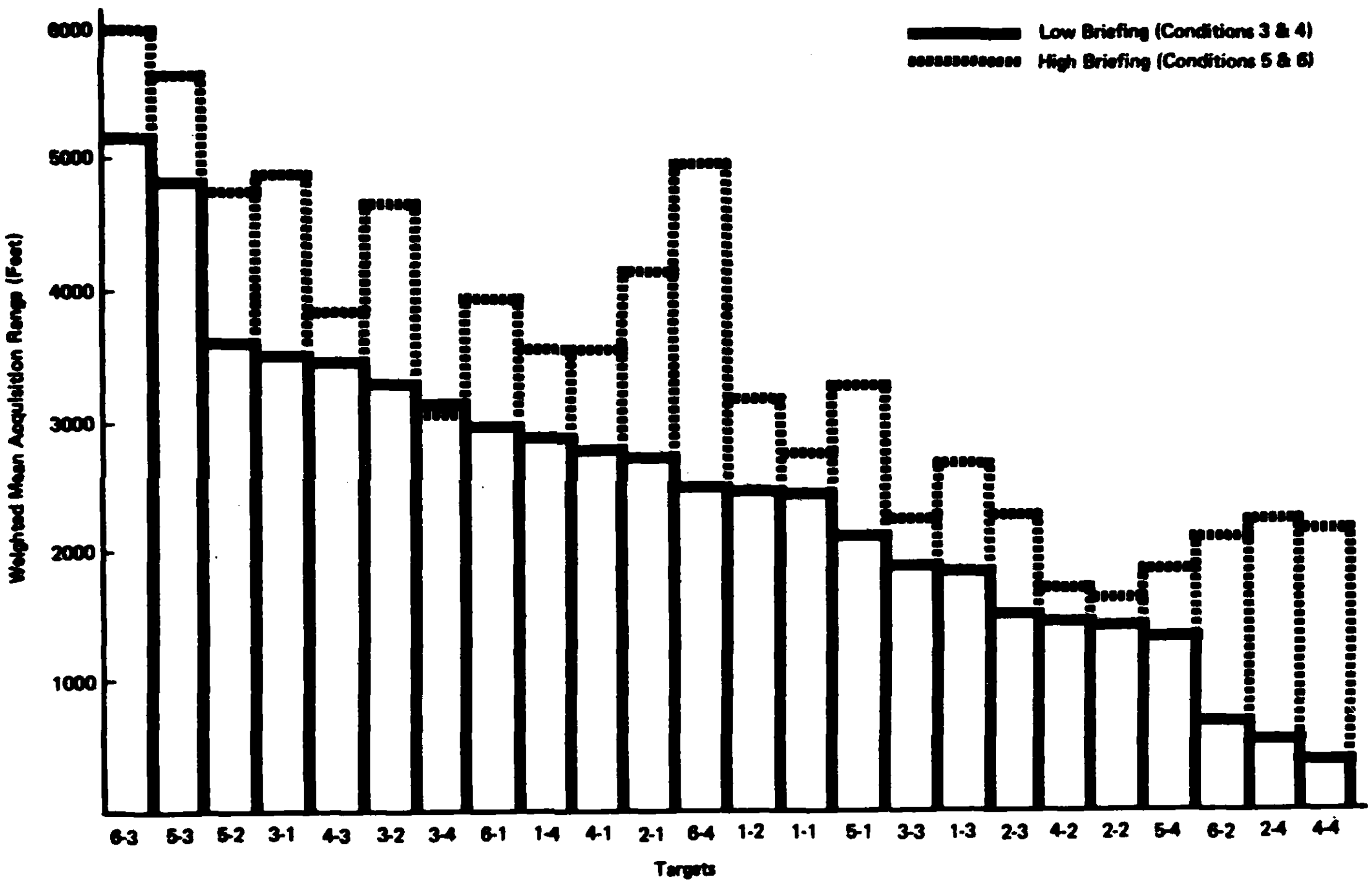

Figure A-11. Weighted Mean Acquisition Ranges With High and Low Briefing

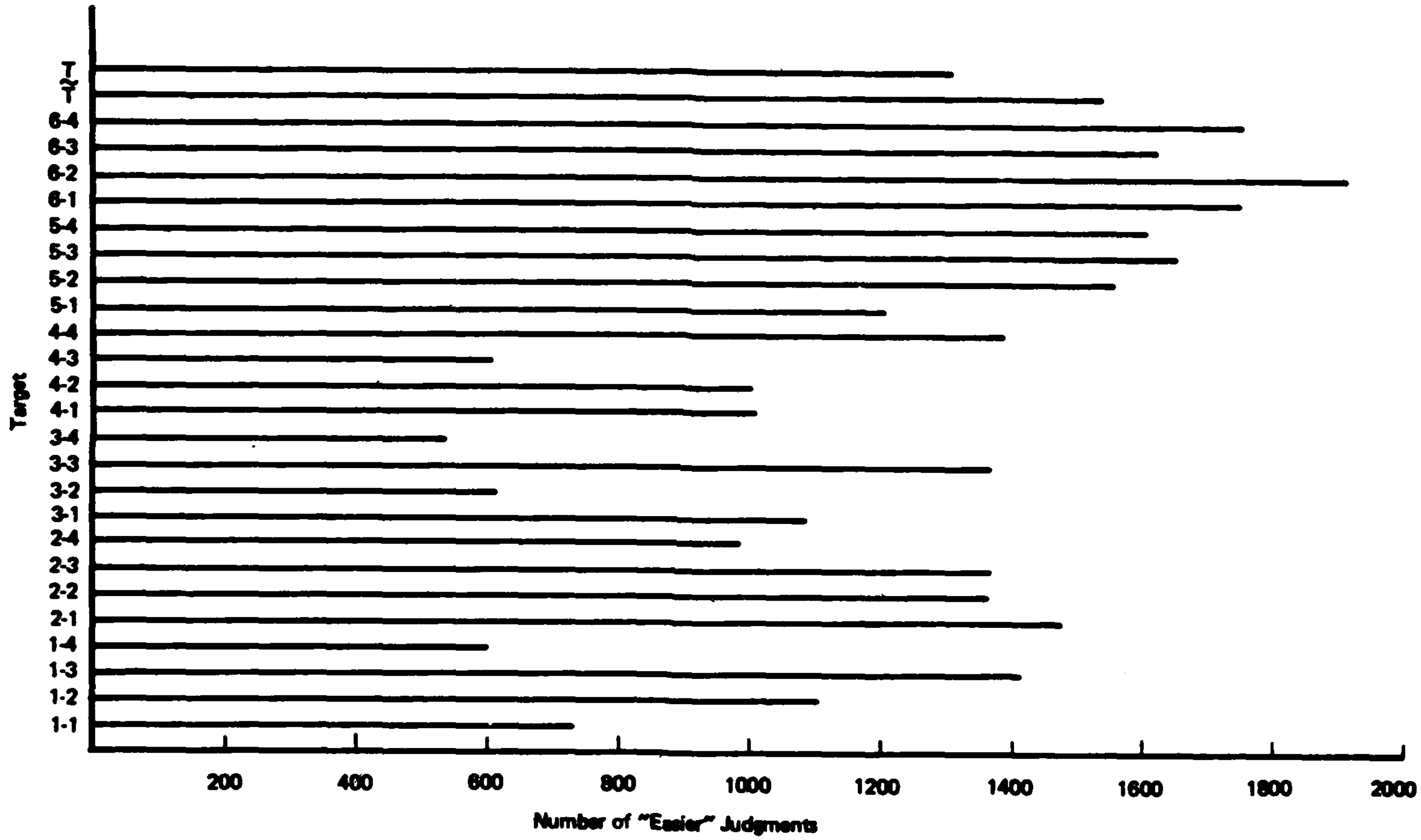

Figure A-12. Number of "Easier" Judgments on Seekval IA2 Targets — Complexity Study

Table A-9. "EASIER" JUDGMENTS ON SEEKVAL TARGETS - COMPLEXITY STUDY

TARGET	Total Times Judged "Easier"	Rank	Proportion of Times Judged "Easier"	Complexity Index *
1-1 Medium AA Battery	730	22	.29	9.0
1-2 Self-Propelled Howitzers	1103	17	.44	35.6
1-3 Pontoon Bridge	1418	10	.57	66.7
1-4 Towed Howitzers	602	25	.24	4.8
2-1 Vehicle Park	1475	9	.57	66.7
2-2 POL Site	1360	14	.54	60.6
2-3 Howitzer Battery	1362	12.5	.54	60.6
2-4 Helicopter Pad	986	21	.39	24.2
3-1 Tank Platoon	1088	18	.44	35.6
3-2 Anti-Tank Battery	615	23	.25	5.5
3-3 FROG Site	1362	12.5	.54	60.6
3-4 SAM Site	536	26	.21	3.2
4-1 Tank Convoy	1003	19	.40	26.4
4-2 Vehicle Park	1002	20	.40	26.4
4-3 SAM Site	609	24	.24	4.8
4-4 AA Machine Guns	1386	11	.55	63.3
5-1 Medium AA Battery	1203	16	.48	45.2
5-2 SAM Convoy	1555	7	.62	78.5
5-3 Truck Convoy	1649	4	.66	85.3
5-4 Heavy AA Battery	1604	6	.64	82.1
6-1 SAM Convoy	1744	3	.70	90.3
6-2 Light AA Battery	1906	1	.76	95.4
6-3 Tank Convoy	1616	5	.65	83.6
6-4 Vehicle Park	1749	2	.70	90.3
T Tank Platoon, High Clutter	1304	15	.52	55.6
Ť Tank Platoon, Low Clutter	1533	8	.61	76.4

* Entries reflect percent of target set judged more complex.

The targets in missions 4, 5 and 6 were generally placed along or close to prominent roads while the targets in missions 1, 2 and 3 were not. It is interesting to note that the target approach areas in missions 4, 5 and 6 were usually judged easier than the others. Average number of "easier" judgments for missions 4, 5, and 6 was 1419 and for missions 1, 2 and 3 it was 1053.

(2) Complexity Index. In order to place the targets on an easily interpreted scale, a Complexity Index was calculated for each target approach. This was accomplished in the following way: first, the proportion of times each target approach was judged to be "easier" by the subjects was calculated by dividing the total number of "easier" judgments by the total number of times the target approach was viewed. The proportions ranged from .21 to .76. Then a z score was calculated for the proportions found for each target. The z score for each target proportion was then converted to a value from a table of cumulative normal proportions. The resulting Complexity Index is a number potentially ranging from 0 to 100 which indicates the percentage of all target approaches in this study which were judged "more complex" than the target approach in question. Thus, a target approach with a Complexity Index of 60.6 would probably be judged "easier" than 60.6 percent of all possible target approaches within the set. The complexity Index for each target is shown in Table A-9.

(3) Reliability. Reliability of a scale is frequently assessed by splitting the scaling entities (sometimes test items but here subjects) in half, deriving the scale for each half independently and then correlating the two scales. This was done with the present data by correlating the scale contributed by subjects from Whidbey and El Toro with that from the Rucker and George subjects. The resulting correlation (where 1.0 is perfect) was .989. The obvious interpretation is that these subjects, working with the materials and instructions given, yielded a scale with extremely high reliability.

Scale construction theory contains an extension of the reliability logic which, given an obtained reliability, allows us to estimate the reliability we would have gotten with some other number of subjects. Figure A-13 shows the result of this calculation. Only 10 subjects, for example, would be required for a reliability of .90.

It was of interest to see if the scale generated by the fixed wing aircraft crewmen differed from that obtained from the rotary wing aircraft crewmen. When the scale generated by the 65 fixed wing aircraft crewmen was compared with that from the 23 rotary wing

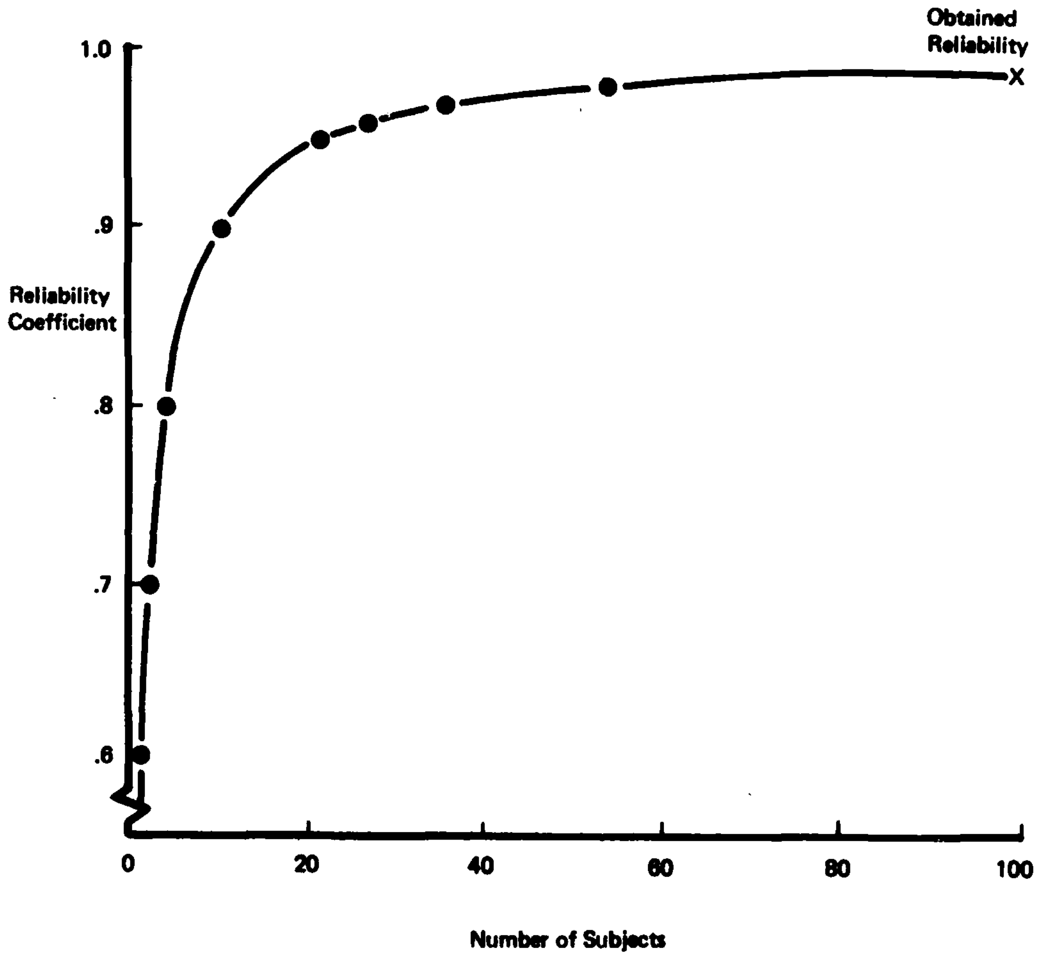

Figure A-13. Estimated Reliability as a Function of Number of Subjects — Complexity Study

aircraft crewmen (dual-qualified subjects were excluded), the resulting correlation coefficient was .976. Clearly, fixed and rotary wing aircraft crewmen behaved similarly in this study.

c. <u>Ambiguity Study</u>.

(1) Data Treatment. The results of the Ambiguity Study are summarized in Figure A-14 which shows the average number of "target-like" items counted by the 100 subjects in each of the 26 target-approach areas.

As can be seen in Table A-10, the ordering of the targets by Ambiguity scale is somewhat different from that obtained in the Complexity Study. This fact will be discussed in a subsequent section of the report.

In general, more "target-like" items were counted in scenes containing definite road-patterns (an average of 5.748 for the targets in missions 4, 5 and 6) than in more isolated areas (an average of 4.626 for the targets in missions 1, 2 and 3).

a list of the types of things counted by the subjects as "target-like" items is shown in Table 3-A-2 in Appendix 3 to this Annex.

As was anticipated, the terrain table scenes (T and $\tilde{T}$) were judged somewhat less ambigious than the majority of the "real world" scenes. Although specifically selected to show different clutter levels, the difference between the two terrain table target-approach areas (as reflected by the "target-like" item count) was insignificantly small.

(2) Ambiguity Index. An Ambiguity Index was calculated for each target. This was done by, first, calculating a z score for each target approach from the total number of "target-like" items found in each approach. The z scores were then converted to the corresponding values in a cumulative normal proportions table.

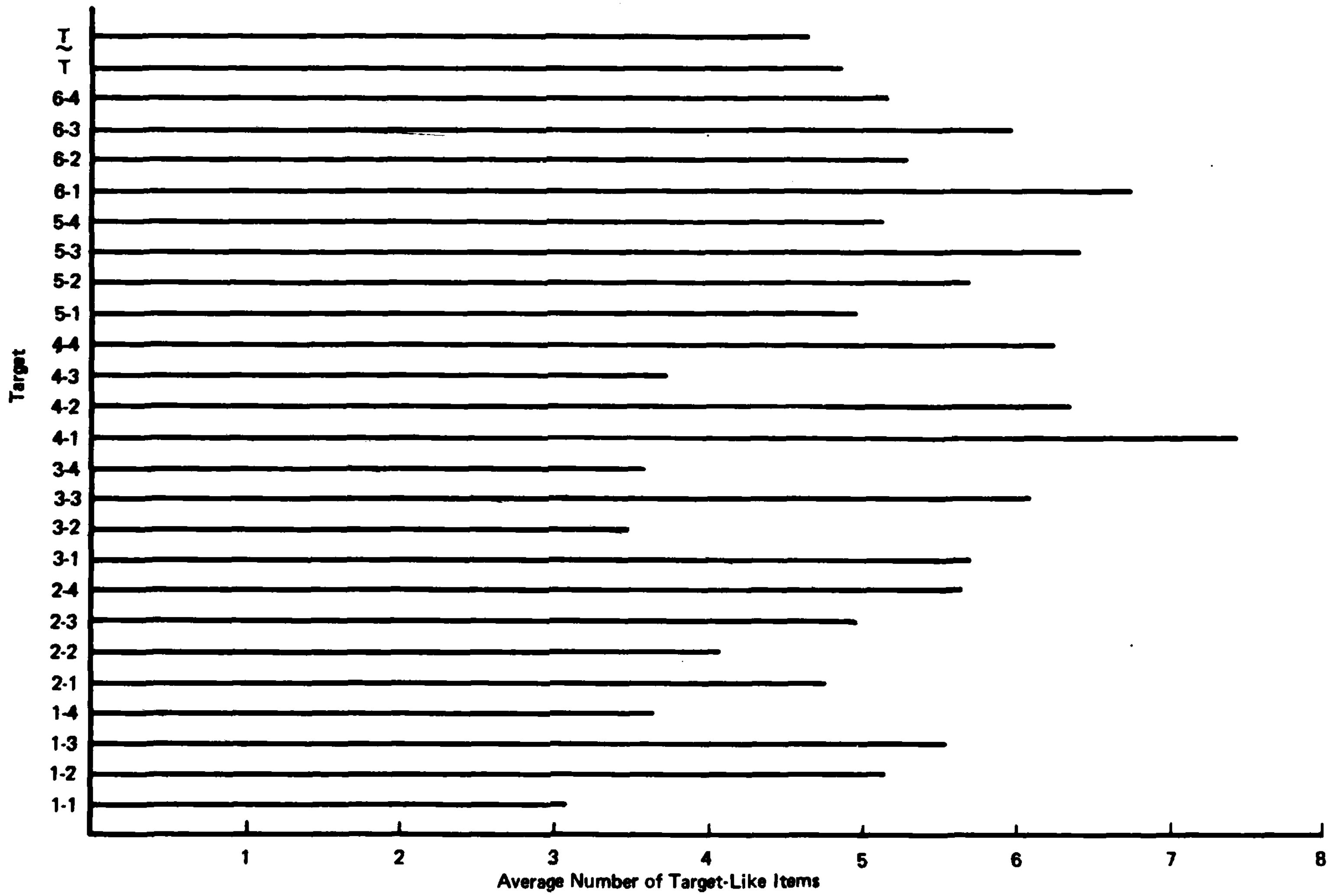

Figure A-14. Average Number of Target-Like Items in Seekval IA2 Targets – Ambiguity Study

TABLE A-10. "TARGET-LIKE" ITEMS IN SEEKVAL

TARGETS - AMBIGUITY STUDY

Target	Mean Number of Target-Like Items **	Rank	Ambiguity Index *
1-1 Medium AA Battery	3.082	26	3.3
1-2 Self-Propelled Howitzers	5.144	13	48.4
1-3 Pontoon Bridge	5.535	11	61.8
1-4 Towed Howitzers	3.628	23	8.7
2-1 Vehicle Park	4.766	19	35.6
2-2 POL Site	4.075	21	16.6
2-3 Howitzer Battery	4.965	16	42.5
2-4 Helicopter Pad	5.638	10	65.2
3-1 Tank Platoon	5.698	8	67.4
3-2 Anti-Tank Battery	3.317	25	5.2
3-3 FROG Site	6.091	6	78.5
3-4 SAM Site	3.576	24	8.1
4-1 Tank Convoy	7.440	1	97.5
4-2 Vehicle Park	6.338	4	84.1
4-3 SAM Site	3.719	22	10.0
4-4 AA Machine Guns	6.238	5	82.1
5-1 Medium AA Battery	4.964	17	42.5
5-2 SAM Convoy	5.679	9	66.6
5-3 Truck Convoy	6.399	3	85.5
5-4 Heavy AA Battery	5.123	15	47.6
6-1 SAM Convoy	6.730	2	91.1
6-2 Light AA Battery	5.237	12	51.6
6-3 Tank Convoy	5.977	7	75.5
6-4 Vehicle Park	5.137	14	48.4
T Tank Platoon, High Clutter	4.630	20	31.2
$\tilde{T}$ Tank Platoon, Low Clutter	4.822	18	37.4

* Entries reflect percent of targets judged less ambiguous.

** Raw Score divided by 1,000

The resulting Ambiguity Index, like the Complexity Index, is a number potentially ranging from 0 to 100 which indicates the percentage of target approaches within the present set of 26 which would probably be judged to contain fewer "target-like" items than the target approach in question. Thus a target with an Ambiguity Index of 48.4 would probably be judged to contain more "target-like" items than 48.4 percent of the target approaches. Table A-10 shows the Ambiguity Index calculated for each target approach.

(3) Reliability. Reliability was assessed for this study by the same method used in the Complexity Study, discussed in section A.4.b.(3). When the scale generated by subjects at Whidbey and El Toro was compared with that obtained at Rucker and George, a correlation coefficient of .981 was obtained. Again, the interpretation is that subjects' performance showed extremely high agreement in their understanding of the task.

The estimated reliabilities for various numbers of subjects are shown in Figure A-15. It can be seen that for a reliability coefficient of .90 only 17 subjects would be required.

A comparison of scales generated by fixed wing aircraft and rotary wing aircraft crewmen resulted in a correlation coefficient of .973, indicating again that these two types of flight crewmen yield highly similar data.

d. Static Detection Study. In this study, 20 subjects attempted to find targets sequences of slides of each of the 26 target approach areas. The dependent variables were target acquisition time, equivalent acquisition range, and number of incorrect acquisitions. The values for these variables on each target are shown in Table A-11.

The 10 slides representing each target approach area were viewed for eight seconds each in a descending range order. When an acquisition response occurred, the controlling clock was stopped, and after the selected "target" was pointed out by the subject, the clock was restarted by the experimenter. Thus acquisition time, reported in the second column of Table A-11, is the mean interval between appearance of the first slide and acquisition of the correct target, less pointing time for incorrect acquisitions. Analysis of the detection time data showed a significant difference in acquisition time for the 26 targets, with a F value of 21.48, $p < .001$.

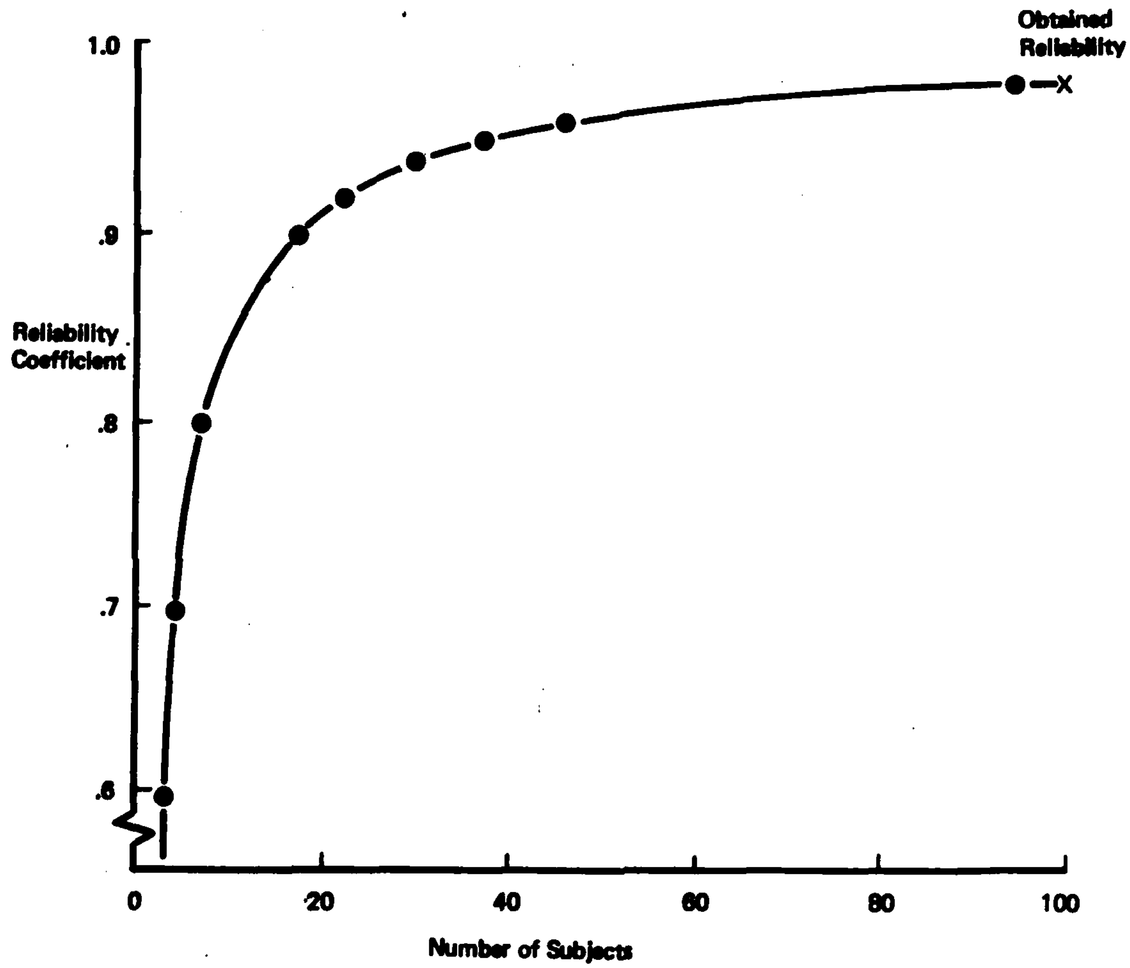

Figure A-15. Estimated Reliability as a Function of Number of Subjects -- Ambiguity Study

TABLE A-11. DEPENDENT MEASURES FROM THE STATIC DETECTION STUDY.

Target	Acquisition Time (Seconds)	Number of Incorrect Acquisitions	Equivalent Acquisition Ranges
1-1	25.4	3	4236
1-2	28.3	7	3157
1-3	34.8	20	2785
1-4	17.5	2	5118
2-1	35.4	13	4133
2-2	25.8	15	2351
2-3	65.6	17	1920
2-4	23.8	7	3761
3-1	23.3	4	5668
3-2	22.1	7	6214
3-3	26.6	8	2994
3-4	21.2	3	3182
4-1	43.6	22	2879
4-2	36.3	8	2713
4-3	43.5	17	4535
4-4	21.4	5	3438
5-1	10.5	5	4527
5-2	32.6	10	3704
5-3	40.1	10	3054
5-4	29.7	10	2534
6-1	18.1	7	3732
6-2	12.0	2	3161
6-3	50.2	16	4719
6-4	18.7	5	5795
$\tilde{T}$	8.2	5	----
T	13.2	8	----

Number of incorrect acquisitions are shown in the third column of Table A-11. These were far more frequent than target misses; only two targets were missed out of the total of 520 target approach area observations, for an overall static acquisition probability of .996.

The fourth column of Table A-11 shows the range represented by the slide on which the average acquisition occurred for each target. This range data is graphically displayed in Figure A-16.

e. Physical Target and Scene Measures. As discussed in the method section, several spatial and light measures were taken on the slides of the targets and their settings. These physical measures represent only "apparent" size and brightness factors as experienced by subjects in the static imagery studies since they were obtained directly from a projection screen used in those studies.

The measures taken on each of the 24 SEEKVAL IA2 targets are summarized in Table A-12 where VISAFL is the visual angle subtended by the major dimension of the target array, and VISAFS is the visual angle subtended by the minor dimension (normal to the major dimension) to the target array. Both measures are from scenes representing 3000 feet ground range to target.

VISANL and VISANS are similar to the above, except that they are taken on a representative target element as viewed from 1000 feet ground range to target. All angular measures are in milliradians of visual angle as applied to an eye reference point located 10 feet from the projection screen.

Table A-12 also presents corresponding linear measurements in a frontal plane, located at the ground, normal to the line of sight. If corrected for aspect differences, the element measures would approximate ground truth information. The array measures represent linear array size in the frontal plane from about 3000 feet range with local terrain masking frequently limiting the measurements. The linear correlations between the four linear measures and their corresponding angular measures are all above .96. Thus, there would be no appreciable difference between linear and angular measures with respect to their effect on the regression analysis and, following the test design, the angular measures were used.

Target 1-1 is a medium antiaircraft battery located in a large hilltop clearing. The target element measured was the outside of one of the six revetments. The array was measured from 3020 feet and included the area of scarred earth in the clearing as masked by trees.

Target 1-2 is a linear array of six revetted self-propelled howitzers. The element measured was one of the howitzers. The array was measured from 3726 feet and several of the near revetments were masked by trees. Target 1-3 is a pontoon bridge. The whole bridge was measured both as element and array. The array measures were taken from 3255 feet and include the effects of heavy local masking. Target 1-4 is an array of six towed howitzers. The prime movers are 2 1/2 ton trucks deployed about the clearing. One of the howitzers was measured as target element. The array was considered to be whole target area as seen from 3216 feet. Again, local masking limited the area measured.

Target 2-1 is a vehicle park located in a large open area. A 2 1/2 ton truck was measured as a representative target element. The array was measured from 2762 feet and no masking involvement was observed. Target 2-2 is POL storage area. The measured target element was one of the two rows of stacked oil drums. The array was partially masked and measured from 3017 feet. Target 2-3 is a pair of revetted self-propelled howitzers. One of the howitzers was measured as a target element and the array was measured from 2880 feet. There was no masking involvement at this range. Target 2-4 is a helicopter pad. One of the helicopters was measured as the target element. The array was measured from 2821 feet and masking did not affect the measurements.

Target 3-1 is a revetted platoon of four tanks. One of the tanks was measured as a target element. The array measures were taken from 2843 feet and there was light masking involvement. Target 3-2 is a pair of revetted anti-tank guns with their prime movers parked nearby. One of the guns was measured as the target element. The array was measured from 3088 feet and there was little masking evident. Target 3-3 is a surface-to-surface missile site supported by four 2 1/2 ton trucks. One of the trucks was measured as the representative target element. The array was measured from 2994 feet. From that range, there was slight masking from local vegetation. Target 3-4 is a SAM site in the clearing on a hill in the woods. One of the missiles was measured as the target element. The array measures were taken from 3182 feet with severe masking constraints.

Target 4-1 is a tank convoy. One of the tanks was measured as the representative target element. The array was measured from 2879 feet. At that range, one of the tanks is masked by a large tree. Target 4-2 is a vehicle park. One of the 2 1/2 ton trucks was measured as the target element. The array was measured from 2713 feet. At that range, there was some local masking. Target 4-3 is a SAM site. One of the SAM launchers was measured as the representative target

element. The array was measured from 2713 feet. At that range, there is some local masking of the target array. Target 4-4 is an antiaircraft machine gun site. One of the guns was measured as the target element. The array was measured from 3003 feet. At this range, one of the two revetments is completely masked.

Target 5-1 is a revetted antiaircraft battery. One of the guns was measured as the representative target element. The array was measured from 3011 feet. At that range, the array is partially masked by local vegetation. Target 5-2 is a SAM convoy. One of the missiles on its transporter was measured as the target element. The array was measured from 3097 feet with no masking involvement. Target 5-3 is a truck convoy. A 2 1/2 ton truck was measured as the target element. The array was measured from 3054 feet with no masking. Target 5-4 is an array of four revetted antiaircraft machine guns. One of the guns was measured as the element. The ground scarred area was measured as the array from 2881 feet with no masking.

Target 6-1 is a SAM convoy. One of the missiles on its transporter was measured as the target element. The array was measured from 2788 feet, and there was no masking. Target 6-2 is an antiaircraft machine gun site. The measured target element was one of the guns. The array was measured from 3161 feet with no masking involvement. Target 6-3 is a tank convoy. One of the tanks was measured as the target element. The array was measured from 3534 feet with no masking. Target 6-4 is a vehicle park. A 2 1/2 ton truck was measured as the representative element. The array was measured from 2919 feet with partial masking of the near elements.

BGNDLU is the background luminance in foot-lamberts, and TGTCON is the target contrast as defined in the method section. It is a well known property of the contrast measure selected that the highest negative contrast achievable is 1.0, but positive contrasts have no limit.

It may be that one of the other available definitions of contrast would be more suitable here, but according to one student of the field (Reference 6), the acceptability of the definition used "rests mainly upon the nearly identical visual effect, at threshold, that has been shown for positive and negative contrasts having the same value by this definition."

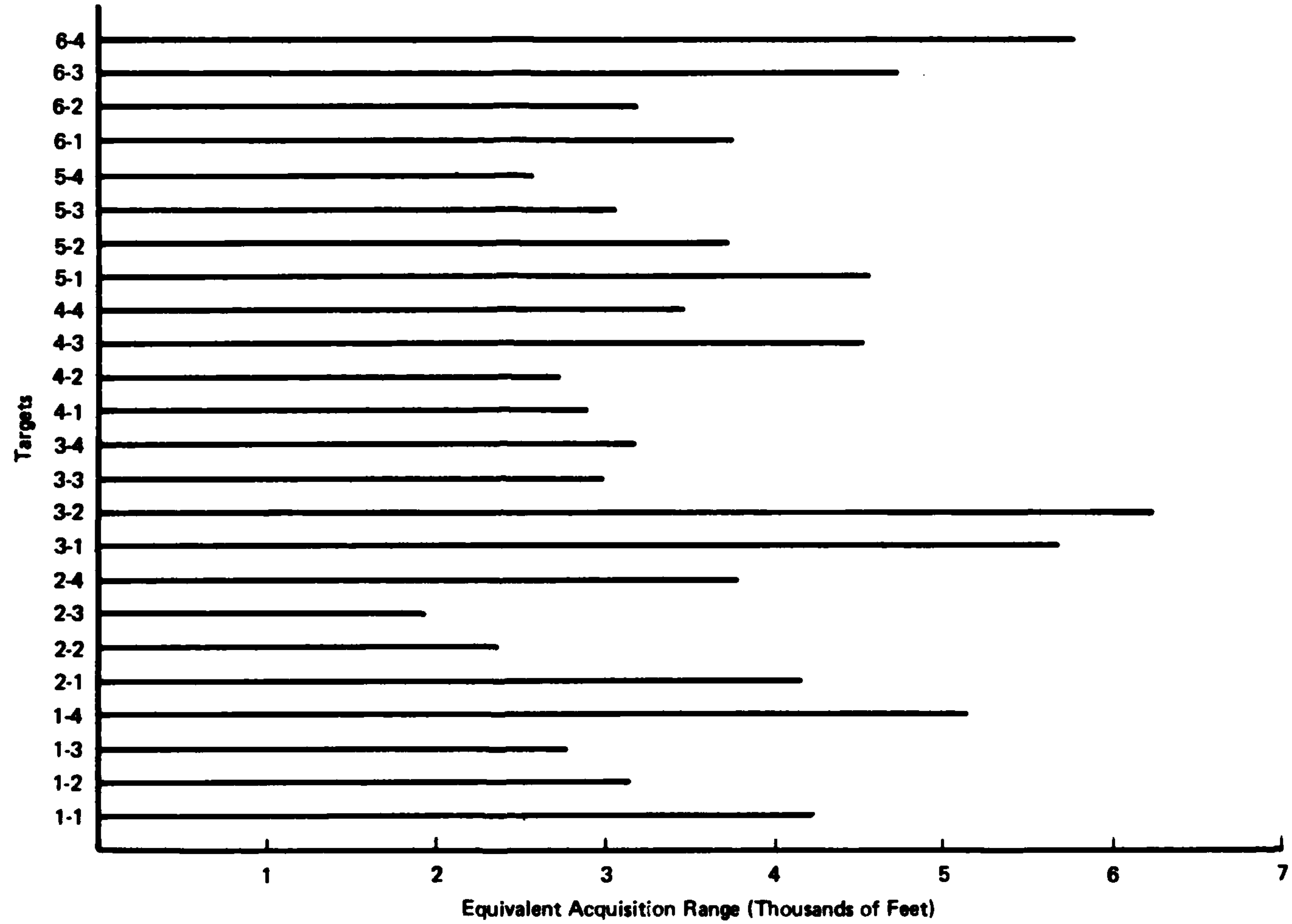

Figure A-16. Average Equivalent Acquisition Ranges for Seekval IA1 Targets – Static Detection Study

TABLE A-12 PHYSICAL TARGET AND SCENE MEASURES

Target	LINEAR MEASUREMENTS (feet) Array Major	Array Minor	Element Major	Element Minor	VISAFL (milli-radians)	VISAFS (milli-radians)	VISANL (milli-radians)	VISANS (milli-radians)	BGNDLU (foot lamberts)	TGTCON	MAR (feet)
1-1	273.3	26.9	38.2	9.9	18.48	1.74	6.98	2.62	8	2.38	6,020
1-2	708.0	51.7	27.7	13.8	40.34	2.91	3.49	1.65	20	- .25	5,059
1-3	45.0	12.9	100.1	29.1	3.02	.87	19.08	5.82	26	- .27	4,628
1-4	917.8	62.0	13.1	5.2	64.00	3.96	5.04	1.94	18	- .50	6,393
2-1	461.5	57.4	25.6	18.8	32.29	3.02	5.04	3.49	15	.80	6,876
2-2	68.6	6.0	132.0	5.6	4.65	.39	25.70	1.07	20	- .30	3,369
2-3	192.3	59.8	33.6	13.4	12.67	3.84	6.79	2.62	9	2.56	9,658
2-4	41.8	22.3	77.7	29.1	2.42	1.36	14.22	5.62	7	.43	4,721
3-1	391.4	78.7	20.7	7.8	26.37	5.33	4.46	1.65	14	2.00	7,080
3-2	213.7	24.4	9.4	6.5	14.04	1.55	1.84	1.36	8	.63	7,758
3-3	142.1	97.7	23.9	8.8	9.62	6.59	4.85	1.84	15	- .40	4,293
3-4	91.2	15.7	22.5	6.7	6.98	1.07	4.94	1.45	6	2.67	4,651
4-1	84.0	10.0	14.7	10.0	5.33	.58	3.02	2.33	30	- .83	6,586
4-2	332.0	21.5	26.8	10.6	9.74	1.26	5.43	2.04	10	- .50	4,535
4-3	628.3	79.2	24.5	9.7	37.62	4.46	5.14	2.42	5	4.20	9,092
4-4	129.1	11.9	5.0	3.6	8.63	.78	.97	.68	9	2.56	4,287
5-1	381.4	50.6	13.3	7.2	25.60	3.37	2.52	1.36	12	1.08	5,047
5-2	67.3	10.7	8.2	4.4	4.65	.68	3.02	1.55	11	1.91	7,018
5-3	172.1	12.1	9.8	7.4	11.46	.78	2.04	1.36	8	1.25	8,512
5-4	168.1	19.9	4.5	3.4	11.85	1.36	1.07	.68	6	.67	3,596
6-1	99.3	6.9	14.3	6.7	6.59	.48	2.72	1.26	11	2.18	5,553
6-2	26.5	7.8	6.4	3.8	1.65	.48	1.16	.68	7	.29	3,578
6-3	115.1	12.2	9.0	7.2	9.62	.68	1.55	1.26	18	- .78	13,126
6-4	462.7	41.8	28.5	15.8	30.74	2.52	5.72	3.02	10	- .30	7,375

NOTE: Negative TGTCON values indicate that the target is darker than the background.

In additon to these measures, the target availability range (MAR) for each target is shown in the last column of Table A-12. The entries are based on the calculations outlined in Section A.3.f.(3).

f. Development of the Regression Model. The intent of this section is to assemble the target-related variables measured in the various static studies and the condition-related variables (speed, cueing and briefing) studied in the Dynamic Imagery Experiment. The assembly consists of a set of regression equations which predict subject performance in the six conditions of the Dynamic Imagery Experiment. From the regression analysis, we determine a set of weights, for each condition of the Dynamic Imagery Experiment, to be applied to each of the target-related variables. Predicted acquisition range for a given target under a given condition of the study is then made by multiplying each of the target specific variable measures by the mission (or condition) specific weights and then summing the weighted variables. The remaining paragraphs of this section detail this analytic procedure and its result.

(1) Intercorrelation of Variables. The first step in the regression analysis was the calculation of an intercorrelation matrix. Each of the 24 targets served as a single case for which the physical measures and the results from the static and dynamic imagery experiments were arranged. The resultant 18-variable correlation matrix based on 24 cases is shown in Table A-13. It is, of course, beyond the scope of this discussion to detail the meaning of all the intercorrelations shown. Therefore, only aspects of Table A-13 which bear some relevance to the regression analysis will be mentioned here.

Inspection of the correlations between pairs of variables among those numbered 1 through 11 (obtained from static imagery) shows that these variables are moderately independent of one another, as was anticipated. Noteworthy exceptions to this are enclosed in rectangles. The relatively high correlations between variables 1 and 2, 3 and 4, and 5 and 6 are not surprising when one considers that a target's major and minor dimensions would generally bear some positive relationship to each other, and that background luminance is a component of the equation for target contrast.

The correlation of .566 between variables 7 (complexity) and 8 (ambiguity) is somewhat disturbing, for not only is the value relatively high, but the sign of the value was expected to be negative. It will be recalled that a high complexity score means that a given scene was judged "easy" for target acquisition, whereas a high ambiguity score means that a scene was judged to contain many "target-like elements." The obtained correlation could be interpreted as saying that scenes containing many target-like elements are easier for

TABLE A-13. CORRELATION MATRIX OF VARIABLES USED IN REGRESSION ANALYSES.

VARIABLE	VISAPL	VISAPS	VISAEL	VISAES	BGNDLU	TGTCON	COMPLX	AMBIGU	DETTIM	SDETR	MAR	ACQR1	ACQR2	ACQR3	ACQR4	ACQR5	ACQR6	ACQRT
NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.000	.578	-.191	-.011	.061	.014	-.376	-.427	-.146	.502	.204	.221	.305	.270	.198	.243	.247	.263
2		1.000	-.122	.072	-.034	.134	-.274	-.195	.027	.274	.125	.032	.124	.104	-.007	.012	.030	.059
3			1.000	.529	.342	-.210	-.071	-.202	.062	-.286	-.294	-.331	-.308	-.326	-.292	-.363	-.416	-.354
4				1.000	.235	-.137	-.139	-.001	.239	-.005	.010	-.001	-.118	-.196	-.157	-.055	-.122	-.114
5					1.000	-.615	.041	.326	.164	-.146	.002	.095	.072	.060	.159	.008	.079	.085
6						1.000	-.224	-.289	.078	.057	.144	.020	.181	.150	.032	.106	.010	.091
7							1.000	.566	.030	-.270	-.007	.013	-.174	-.115	-.066	.056	.122	-.036
8								1.000	.215	-.333	-.001	.011	-.158	-.047	-.009	.009	.147	-.007
9									1.000	-.375	.622	.201	.325	.227	.287	.101	.148	.235
10										1.000	.391	.569	.525	.425	.427	.657	.597	.555
11											1.000	.766	.839	.692	.764	.724	.752	.798
12												1.000	.900	.854	.898	.923	.910	.957
13													1.000	.916	.929	.869	.855	.957
14														1.000	.956	.844	.881	.953
15															1.000	.837	.898	.964
16																1.000	.930	.939
17																	1.000	.956
18																		1.000

1. Target Array Major Dimension
2. Target Array Minor Dimension
3. Target Element Major Dimension
4. Target Element Minor Dimension
5. Background Luminance
6. Target Contrast
7. Complexity Raw Score
8. Ambiguity Raw Score
9. Static Study Mean Detection Time
10. Static Study Range-to-Target at Detection
11. Visual Maximum Available Range
12. Dynamic Study Mean Acquisition Range (Condition 1)
13. Dynamic Study Mean Acquisition Range (Condition 2)
14. Dynamic Study Mean Acquisition Range (Condition 3)
15. Dynamic Study Mean Acquisition Range (Condition 4)
16. Dynamic Study Mean Acquisition Range (Condition 5)
17. Dynamic Study Mean Acquisition Range (Condition 6)
18. Dynamic Study Mean Acquisition Range (Across Conditions)

target acquisition than scenes containing fewer such elements. This interpretation, however, is probably unwarranted. It is more likely that the two underlying scales are addressing the same aspects of target scenes. A review of the instructions given subjects in the two related experiments supports this latter hypothesis. In the Ambiguity Study subjects were told to "count the number of cues, or things, that catch your attention ..." It could be that these instructions inadvertently led to item counts which were covertly used by the Complexity Study subjects to designate "easier" scenes and thus resulted in two scales on similar scene characteristics.

Variables 12 through 18 represent the performance obtained in the Dynamic Imagery Experiment under controlled levels of cueing, briefing and simulated aircraft speed. The pairwise correlations among these variables are shown in the circumscribed area in the lower right corner of Table A-13. (These were used individually as criterion measures in the regression analysis discussed below.) The entries above this area show the correlations between individual static imagery (independent) variables and each of the criterion (dependent) variables. Although these correlations are relatively low, the joint effect of the static imagery variables on the criterion variables is quite high as will be seen later.

Variable 9 (Detection Time) and Variable 10 (Detection Range) are alternative candidates for representing the results of the Static Detection Study in the regression analysis. In that study, the sequence of slides closing on any one target represented equal intervals of that target's MAR. Since the slides were presented in equal intervals of time, the detection time measure was heavily dependent on MAR. Thus, MAR was "built into" Variable 9, as indicated by the high positive correlation ($r_{9,11} = .622$). On the other hand, the correlation between Variable 10 and MAR is still positive but lower ($r_{10,11} = .391$). This is a reasonable experimental result rather than a procedural artifact. For this reason, and because low intercorrelation among predictors is desirable, Variable 10 (Static Detection Range) was used in the regression analysis.

(2) Regression Analyses. Linear multivariate regression analyses were performed to quantitatively assess the contributions of physical measures and static imagery study variables on simulator target acquisition performance under specific controlled flight conditions. A linear stepwise regression technique was used which facilitates evaluation of the contribution made by each independent variable (as well as combinations of variables) on the predicted dependent variable. The set of independent variables used consisted of variables 1 through 8, 10, and 11 as shown in the key to Table A-13.

Weighted mean acquisition ranges obtained under each of the conditions of the dynamic study [ACQR(I), I = 1, ...,6] and weighted mean acquisition ranges across conditions (ACQRT) served as dependent variables in separate regressions. Means used were computed on a target by target basis across subjects, and the 24 targets served as individual cases in the regressions.

The selected variables were included in regression equations of the following general form:

$$a_{jk} = \sum_{i} w_{ij} v_{ik} + b_j$$

where

$i = 1,2, \ldots 8, 10, 11$ is the index for variables;

$j = 12, 13, \ldots 18$ i the index for conditions;

$k = 1, 2, \ldots 24$ is the index for targets;

a_{jk} = predicted acquisition range for target k and under condition j;

w_{ij} = regression coefficient (or weight) for variable i in condition j;

v_{ik} = independent variable i measured on target k; and

b_j = constant term associated with the regression equations for condition j.

Note that the values taken by the i and j subscripts correspond with the variable numbers shown in Table A-13 and that variable 9 is excluded.

The regression analyses proceded in the following manner: In the first step, the independent variable correlating most highly with the dependent variable was used to compute the regression equation. In each subsequent step, the independent variable resulting in the greatest reduction in the error sum of squares was added to the equation. This was also the variable having the highest partial correlation with the a_{jk} variables computed in the preceeding step. Thus changes in regression equation sensitivity due to the addition of independent variables were available for evaluation. The stepping procedures were terminated either after all independent variables were included in the equation or when the reduction of error sum of squares became insignificantly small.

The general effectiveness of these procedures can be assessed by inspection of the multiple correlation coefficient (R) between the predicted weighted mean acquisition ranges and those obtained under the various experimental conditions. Furthermore, $R^2 \times 100$ is interpretable as the percent of target/background-related variance which can be accounted for by means of the combined influence of the static imagery measures. This percentage will change as a function of the effect due to condition-related variables.

A summary of the prediction effectiveness when using all significant static imagery variables is as follows:

Dynamic Imagery Experimental Condition	R	$R^2 \times 100$
1) Range-to-go, 360 kts, Low-Briefing	.8581	73.63
2) FAC, 360 kts, Low-Briefing	.9122	83.21
3) No Cueing, 360 kts, Low-Briefing	.7701	59.31
4) No Cueing, 220 kts, Low-Briefing	.8410	70.73
5) No Cueing, 360 kts, High-Briefing	.8835	78.06
6) No Cueing, 220 kts, High-Briefing	.8988	80.78
7) Overall (across conditions 1-6)	.8774	76.98

Inspection of Table A-14 reveals the increase in predictive accuracy (or sensitivity) to be gained from increasing the number of variables contained in the regression equations. It can be seen that between 59 percent and 83 percent ($R^2 \times 100$) of the observed variance in the Dynamic Imagery Experiment can be accounted for by using the appropriate regression equations. Even by using only the one most consistently effective predictor (visual maximum available range), 48 percent to 70 percent of the observed variance can be handled. The "condition" headings in Table A-14 correspond to those presented above. It should also be noted that the order in which the independent variables serve to increase R^2 appears to vary with the controlled-variable effects of the Dynamic Imagery Experiment.

Another finding is demonstrated in Figure A-17 where it can be seen that a regression equation containing more than five variables generally will produce only minute improvements in the accountability of observed variance. However, since the specific variables included or excluded differ from condition to condition, regression coefficients will be presented which meet a tolerance level of $p < .001$.

TABLE A-14. PREDICTIVE SENSITIVITY GAINED THROUGH STEPWISE REGRESSION

INDEPENDENT VARIABLE	Vi	Step No.	CONDITION 1 Var. Added	CONDITION 1 Multiple R	CONDITION 1 R^2	CONDITION 2 Var. Added	CONDITION 2 R	CONDITION 2 R^2	CONDITION 3 Var. Added	CONDITION 3 R	CONDITION 3 R^2	CONDITION 4 Var. Added	CONDITION 4 R	CONDITION 4 R^2	CONDITION 5 Var. Added	CONDITION 5 R	CONDITION 5 R^2	CONDITION 6 Var. Added	CONDITION 6 R	CONDITION 6 R^2	OVERALL Var. Added	OVERALL R	OVERALL R^2
Target Array Major Dimensions	1	1	11	.7658	.5865	11	.8388	.7036	11	.6916	.4782	11	.7636	.5830	11	.7242	.5244	11	.7524	.5661	11	.7980	.6368
Target Array Minor Dimension	2	2	10	.8197	.6719	10	.8655	.7490	4	.7206	.5193	4	.7811	.6102	10	.8300	.6889	10	.8212	.6744	10	.8405	.7064
Target Element Major Dimension	3	3	5	.8319	.6921	4	.8743	.7644	10	.7395	.5468	5	.8070	.6512	7	.8508	.7239	8	.8699	.7566	5	.8501	.7226
Target Element Minor Dimension	4	4	2	.8438	.7120	5	.8854	.7839	5	.7523	.5660	10	.8253	.6812	2	.8634	.7455	4	.8787	.7721	4	.8639	.7463
Background Luminance	5	5	3	.8518	.7255	6	.9009	.8116	6	.7651	.5854	2	.8350	.6972	8	.8673	.7521	2	.8853	.7837	2	.8695	.7561
Target Contrast	6	6	7	.8540	.7293	8	.9073	.8232	7	.7674	.5889	7	.8389	.7038	6	.8708	.7583	1	.8906	.7932	6	.8743	.7644
Complexity Raw Score	7	7	6	.8552	.7314	2	.9094	.8269	2	.7684	.5905	6	.8403	.7062	5	.8799	.7743	7	.8932	.7979	3	.8770	.7691
Ambiguity Raw Score	8	8	4	.8564	.7334	3	.9110	.8299	3	.7691	.5915	3	.8407	.7067	3	.8834	.7804	5	.8959	.8026	7	.8774	.7698
Range-to-Target at Detection (Static)	10	9	8	.8569	.7343	7	.9117	.8311	1	.7695	.5922	1	.8408	.7069	1	Not in equation		6	.8982	.8067	1	Not in equation	
Visual Maximum Available Range	11	10	1	.8581	.7363	1	.9122	.8322	8	.7701	.5931	8	.8410	.7073	4	Not in equation		3	.8988	.8078	8	Not in equation	
									variable removed:														
		11							3	.7701	.5931												

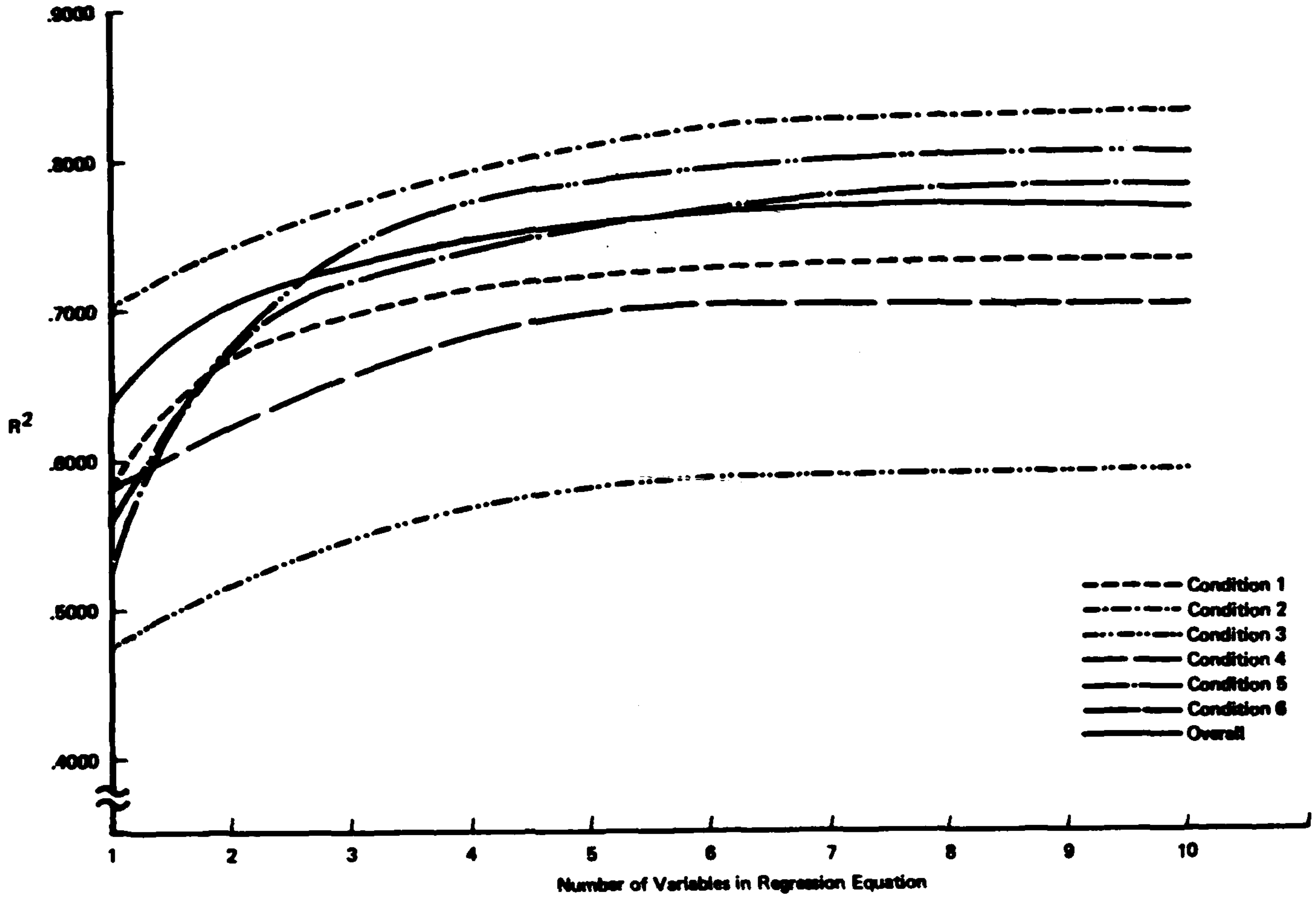

Figure A-17. Prediction Improvement as a Function of Number of Variables in Regression Equation

Additional analyses using ridge regression (Reference 7) were discontinued due to the low intercorrelations among independent variables and the relatively low correlations between individual independent and dependent variables. Under these circumstances it was felt that ridge regression techniques would not significantly improve the predictive capability obtained with stepwise regression.

The regression coefficients obtained are best handled in a matrix format since this is the format of the final regression model to be presented below. The conditions (j) by coefficient (i) matrix (W) having 7 row vectors and 11 column vectors is shown in Table A-15. The matrix W, of course, only represents a summary of regression coefficients under the controlled conditions of the Dynamic Imagery Experiment.

A complete picture of controlled condition effects and target-related variable effects on acquisition performance relative to the current set of experiments is obtained by means of matrix multiplication:

Let

$$W = \begin{bmatrix} w_{12,1} & & w_{12,4} & b_{12} \\ & w_{ji} & & \\ w_{18,1} & & w_{18,4} & b_{18} \end{bmatrix}$$

$i = 1, 2, \ldots 8, 10, 11$ (independent variables)

$j = 12, 13 \ldots 18$ (conditions)

Note: j=18 corresponds to ACQRT, data averaged across the six conditions; b_j is a constant term associated with condition j.

be the conditions-by-variables matrix of mission-related coefficients or weights as shown in Table A-15, and let

$$V = \begin{bmatrix} v_{1,1} & & v_{1,24} \\ & v_{ik} & \\ v_{11,1} & & v_{11,24} \end{bmatrix}$$

$i = 1, 2, \ldots 8, 10, 11$ (independent variables)

$k = 1, 2, \ldots 24$ (targets)

TABLE A-15 CONDITIONS-BY-VARIABLES MATRIX OF MISSION-RELATED COEFFICIENTS (W)

Note: Entries are w_{ji} and b_j of the regression equations.

Independent Target/Background-Related Variables

Dynamic Imagery Experiment Condition Variables

j= \ i=	1	2	3	4	5	6	7	8	10	11	b_j
12	-6.08	-89.32	-43.80	68.30	52.12	59.50	0.3405	-0.0929	0.4386	0.3177	-1402.98
13	-5.14	-50.40	-23.01	-148.41	77.93	205.29	-0.1671	-0.2119	0.3067	0.4639	- 271.35
14	5.07	-51.12	0.00	-222.94	43.01	150.27	-0.2832	0.0657	0.2204	0.3201	- 617.45
15	-2.88	-102.43	-10.89	-179.82	57.63	59.63	-0.1954	-0.0371	0.2288	0.3616	- 177.76
16	0.00	-127.98	-20.88	0.00	41.89	173.19	0.5323	0.0305	0.6173	0.2497	-1697.65
17	9.23	-127.54	-12.99	-92.15	33.54	90.22	0.4361	0.2570	0.5906	0.3202	-2717.14
18	0.00	-88.04	-18.79	-96.33	51.56	124.02	0.09453	0.00	0.3897	0.3424	-1127.10

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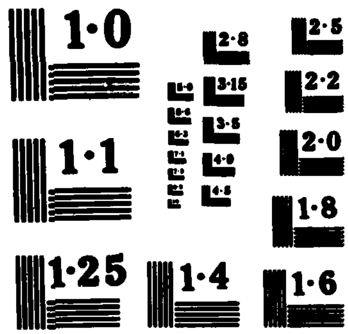
1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

be the variables-by-targets matrix of target-related physical and static measures.

Then

$$A=WV$$

represents the conditions (j) by targets (k) matrix of predicted mean acquisition ranges which summarizes the expected target acquisition performance under the conditions investigated in the SEEKVAL IA2 Direct Imagery Experiment. Individual elements of the A matrix (a_{jk}) are the same as those obtained by using the general regression equation given earlier. The standard error of estimate associated with the family of regression equations for each condition is 871, 816, 1,025, 878, 715, 808, and 743 feet of weighted mean acquisition range for conditions 1 through 6 and "overall" respectively. The computed a_{jk} elements of matrix A are contained in the Target Summary Tables of Appendix 4 as Predicted Weighted Mean Acquisition Ranges.

(3) Application of Regression Results. One of the tasks in the IA2 project involved the evaluation of the impact of target/background - related variables on target acquisition performance. These are the regression equation independent variables which varied with targets, but not experimental conditions. The set of 24 targets, ordered by weighted mean acquisition range, can serve to clearly reflect the differentiation in acquisition performance due to target-related variables, as shown in Figure A-18, for the data averaged across conditions. In addition, Figure A-18 shows the predicted acquisition performance and the resultant change in target order within the target-set used.

The Spearman rho correlation coefficient between obtained and predicted target order of .89 is statistically significant ($p < .01$). This indicates that a predicted order of targets based on target-related variables bears close resemblance to an ordering based on experimentally obtained performance measures.

It should also be noted that changes in target order (from the one shown in Figure A-18) occurring in conjunction with individual conditions of the Dynamic Imagery Experiment reflect primarily the influence of different condition-related variables rather than target-related variables, since the target set was the same for all conditions.

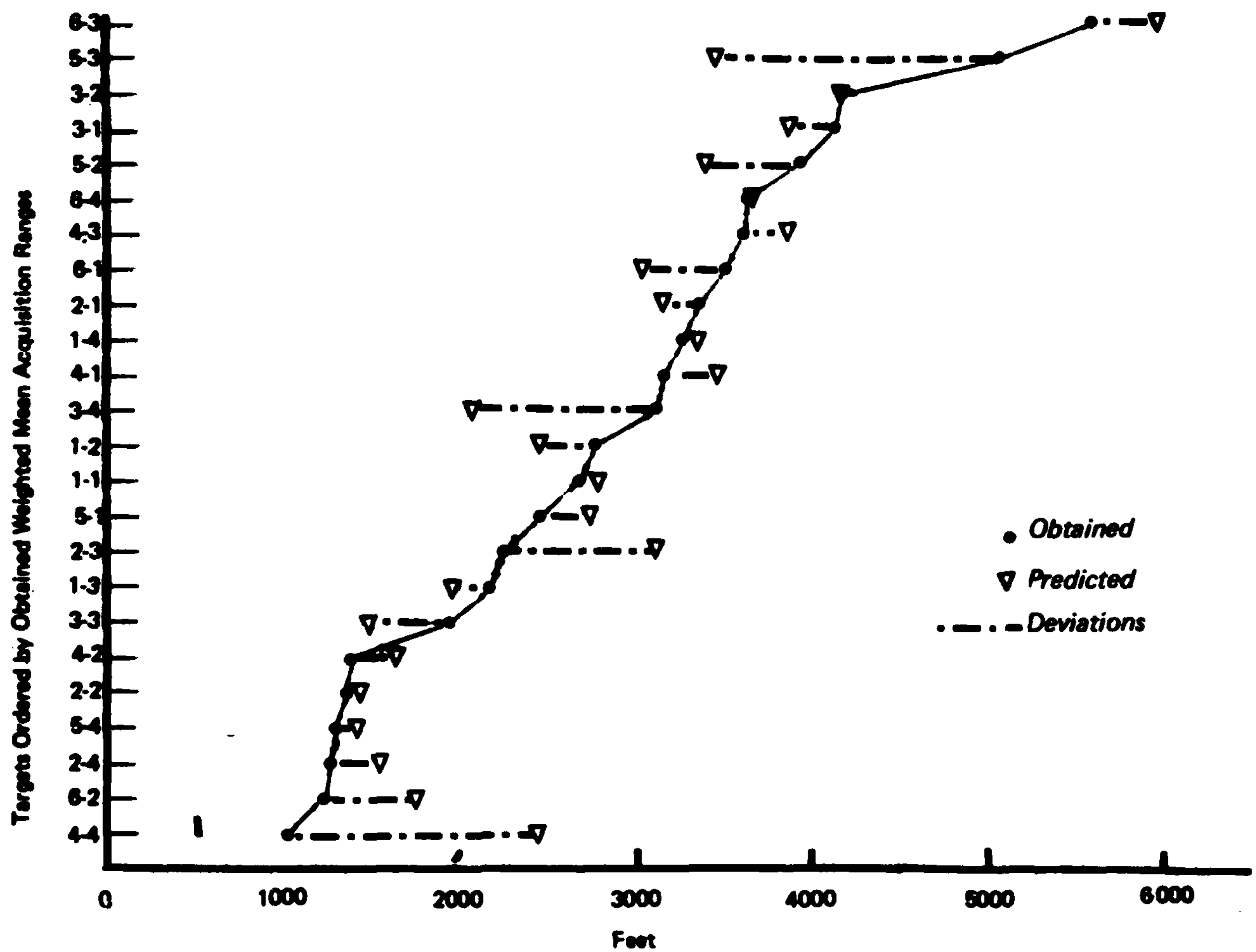

Figure A-18. Comparison Between Obtained and Predicted Acquisition Performance

g. Discussion

(1) Static Imagery Based Data. The physical measures of apparent target size, contrast, and background luminance as well as the subjective judgment data on scene complexity and ambiguity discriminated quite well among the target-set used.

Results of the terrain table imagery are inconclusive in that no clear-cut differences could be established between the two levels of clutter (ambiguity) defined a priori for the target and its setting. However, complexity judgments and static detection times did differentiate between the two terrain table target settings in the anticipated direction. In general, static detection times for both terrain table targets were well below average detection times on "real-world" scenes. The complexity judgments fell close to the average judgments for "easier" and "more difficult" real world targets. Furthermore, informal comments by test subjects indicated that they would prefer the use of only real world scenes in subsequent studies.

It appears that whatever the increase in flight profile flexibility which can potentially be gained by using terrain tables in direct visual target acquisition performance assessment may be compromised by the effects on performance associated with a concurrent increase in search-scene abstractness or artificiality. This compromise may not reflect itself in subjective judgment of "terrain table quality", but is suspected to influence target acquisition performance since target/background cue effects are only partially understood.

(2) Dynamic Imagery Based Data. The performance data obtained with the controlled variables in the Dynamic Imagery Experiment was consistent with previous findings on interdiction-type targets and thus augment the available data base by providing data on tactical targets. In Reference 8, it was reported that in the JTF-2 Basic Validation Study, there was a slight but statistically significant decrease in acquisition performance when simulated aircraft speed was increased through the range from 192 to 764 knots. The associated field tests yielded similar results across the speed range from 200 to 600 knots. These findings are consistent with the present slight inverse relationship between speed and acquisition performance. Reference 9 is a report of the JTF-2 study on briefing level effects and simulated aircraft speed. It was found that higher levels of premission intelligence yielded significant improvement in target acquisition performance but that a speed increase from 360 to 550 knots had no effect. In summary, the present speed and briefing effects corroborate those found in these earlier studies. The insignificant speed results in Reference 9 may be due to the particular speed band selected which was higher than the present one.

With regard to in-flight cueing, it was found that use of the range-to-go device resulted in only a 4.1% improvement in weighted mean acquisition ranges over the no cueing condition. The FAC, however, improved that

performance by 25.1% over the no cueing condition.

The high-briefing level improved performance by 36.8% over that with the low-briefing level.

Reduction of simulated aircraft speed from 360 knots to 220 knots resulted in a 6.9% performance improvement under the combined briefing conditions. When the high-briefing level is considered by itself, however, only a 3% improvement was seen.

In general, the controlled flight conditions used systematically indicated the influence of the underlying variables and service to confirm that flight-related factors play a significant role in determining target acquisition performance in conjunction with factors pertaining to the target and its setting.

(3) Regression Analyses. The regression analysis effort concentrated on evaluating the predictive capability associated with a set of physical measures and psychophysical judgments on target/background characteristics in relation to simulated dynamic target acquisition performance.

Although the obtained regression equations showed relatively high multiple correlations with experimental performance data, individual independent variables showed low correlation with the dependent variables. Several reasons for this result can be hypothesized. The most likely hypothesis is that the low correlations are associated with the static imagery measurement techniques used.

It will be recalled that all physical measures used were of "apparent" size and illumination characteristics, as projected onto a flat surface screen. Further, all physical measures were based on target/background scenes as viewed at either 3000 or 1000 feet range-to-target. Although these procedures provided good control over the scene characteristics being measured, it is probable that the relationship between range-to-target for measurement and dynamic acquisition performance, as well as the interactive influence of physical scene characteristics, is more complex than anticipated. Only further experimentation and analysis can resolve the issue.

No clear-cut hypothesis can be formed which would explain the low correlations between the psychophysical judgment data and dynamic target acquisition performance. It can be speculated that one contributing factor was the target-independent nature of the Complexity and Ambiguity Studies experimental design.

(4) Acquisition Difficulty Scale. By structuring the results obtained from using the regression equations, an ordered target set can be established. This ordering of targets can be viewed as representing

a scale of relative acquisition difficulty.

Since target/background factors remained constant for all conditions in the Dynamic Imagery Experiment, rearragement of targets within the Acquisition Difficulty scales are attributable solely to differences in flight-related variables (excluding experimental error).

An acquisition difficulty scale based on target/background factors in isolation, i.e., insensitive to and unaffected by flight-related variables, needs to be systematically established. However, this scale will only contribute one aspect of target acquisition performance. A model having operational utility will necessarily address both flight-related and target/background-related variables, and should be the goal of future research and developments.

5. FINDINGS

The purpose of this project, as stated in the SEEKVAL IA2 Project Plan was "... to identify potentially effective measures of target and scene characteristics and develop a methodology which will use these measures to best predict real-time acquisition performance ... to establish a limited base of visual acquisition performance data." It was emphasized "that the project is exploratory in nature and restricted in scope."

It is concluded that this general purpose of the project was met, that the methodology of stepwise linear regression will suffice - to a first approximation - for the development of a predictive model, and that several of the measures taken have sufficient predictive strength. As detailed below, the potential of some of the other measures is yet to be realized.

The specific objectives of this project were stated in the SEEKVAL IA2 Project Plan and are cited in the main body of this report. They are addressed by number in the following set of conclusions drawn from the measurements, experiments and analyses undertaken in support of the project.

a. Objective 1: Complexity and Ambiguity Scale

(1) When subjects are asked to determine in which of a pair of pictures it would be easier to find an unspecified small tactical target, they respond with high agreement. There is so much agreement that subsequent similar efforts can be accomplished with many fewer than the 100 subjects used here and still maintain a high level of reliability. The same is true when subjects are asked to count the number of target-like objects or cues as in the present Ambiguity Study.

(2) A corollary to the high reliability is that fixed wing and rotary wing observers yielded highly similar scales in both of these studies.

(3) The validity of the Complexity and Ambiguity Scales, as measured by the correlation between their two scales and weighted mean acquisition ranges from the Dynamic Imagery Experiment, was low. This indicates that, although the two scales measured well, they were of little help in predicting target acquisition performance. The probable reasons are the selection of imagery or the particular questions asked, or both.

(4) The amount of variance in acquisition performance due to targets and target/background effects are large. In the cueing analysis of variance, target/background effects accounted for 74.6% of the variance

and in the speed by briefing analysis 34.7% of the variance was attributable to target and target/background differences. This highlights the importance of continuing study of targets and target backgrounds.

(5) In the analysis of variance for cueing effects 20.1 percent of the variance was due to performance differences among the three cueing conditions. The analysis of variance on the speed and briefing effects showed that 58.9 and 2.7 percent of the variance were due to briefing and speed, respectively.

b. Objective 2: Static Detection Study

(1) When subjects are shown sequences of slides approaching targets, mean acquisition time varies significantly as a function of targets.

(2) When mean acquisition time for each target from the Static Detection Study is converted to equivalent acquisition range, the resulting scale shows moderately high correlation with weighted mean acquisition range in the Dynamic Imagery Experiment.

c. Objective 3: Regression Model Validity

(1) By regression analysis, the aggregate of the static measures taken in this project showed multiple correlations with weighted mean acquisition ranges in the Dynamic Imagery Experiment of between .770 and .912 depending on the experimental condition of the dynamic study from which the acquisition data was taken.

(2) Maximum available range (MAR) was by far the strongest predictor of weighted mean acquisition range, followed by static detection equivalent range, one of the size measures, background luminance or contrast, and complexity or ambiguity.

(3) Most of the predictive strength was gained with the first five or six variables added to the regression equation. Addition of further variables did not appreciably increase the multiple correlation.

d. Objective 4: Regression Methodology

The high multiple correlations obtained in this project indicate that the methodology used here holds a great deal of promise for the development of a predictive model. Two of the predictor variables contributed strongly and candidate refinements have been identified for the remainder.

e. Objective 5: Subject Effects

The amount of variance due to subjects in the Dynamic Imagery Experiment was very small: 1.15 and 0.34 percent in the cueing and speed by briefing analyses of variance, respectively.

f. Objective 6: Dynamic Experiment Main Effects

(1) Inflight cueing provided by a forward air controller improved target acquisition performance in this study, despite the fact that some subjects felt that the FAC was inappropriately used with this mission profile.

(2) Use of a range-to-go display did not affect performance. Subjects found that it was redundant with the elapsed time clock and preferred to use the latter because it was more familiar.

This result raises an important methodological point. When subjects are asked to perform using an unfamiliar device and their performance is to be compared with performance using equipment that is familiar to them, a difference due to familiarity is confounded with inherent equipment differences. This confounding should be obviated by sufficient training on the new device.

(3) Availability of target photographs during the briefing brought about a large improvement in target acquisition performance and a significant increase in the proportion of premature responses.

(4) The difference in weighted mean acquisition range at 360 knots and 220 knots is statistically significant but small in magnitude.

g. Objective 7: Individual Correlations

The correlations between weighted mean acquisition range and the physical measures were low, indicating that refinement of the physical measures or selection of new ones should be undertaken.

6. RECOMMENDATIONS

a. Methodology. An important output of the IA2 Project has been the methodology for an aggregate scale describing target and target/background characteristics in such a way that it predicts dynamic acquisition performance. In view of the success of the linear stepwise regression model in accomplishing this goal, it is recommended that the present methodology be retained for future SEEKVAL studies.

b. Maximum Available Range. By far the strongest single predictor of dynamic acquisition performance was maximum available range (MAR). Conceptually, MAR should be a summary variable correlating highly with target size, brightness and contrast measures. In this project, these correlations were low; that problem will be discussed shortly. Because of its high predictive power, it is recommended that MAR be retained for use in predicting performance on fixed-wing profiles where, as in this study, the approaches are essentially straight-in and begin beyond MAR. Further, because at present MAR appears to describe target and target/background variance better than the physical target measures, mask-free MAR should be retained to predict performance in rotary-wing profiles as well.

c. Masking. MAR is a function of both target/background variables as discussed above and flight profile variables, one of the strongest of which is masking. Masking determined MAR on 4 of the 24 targets in this project. One of these 4 targets consistently showed the largest error between observed and predicted weighted mean acquisition range. In the absence of further study, it is recommended that masked targets be avoided if we want MAR to be a description of target and target/background characteristics. However, since Project IB2 will include rotary-wing flight profiles, it is strongly recommended that masking be studied as a variable in its own right.

d. Physical Measures. As has been stated, the contribution to the predictive regression model made by the physical measures was low. Two general problems arise, both of which contribute to the low correlations.

Due to the large variation in deployment of small tactical target arrays, it was difficult to apply consistent decision rules about what should be measured. This problem appeared in both the angular size measures and the luminance and contrast measures. More effort needs to be devoted to developing consistent decision rules and to trying to discover which of the infinity of measurements that can be made are important determiners of target acquirability.

The second general problem in the physical measurements is that of measurement precision. It is suggested that the size measures be determined from accurate survey data of the ground sites and then trigonometrically projected back to determine angular size at relevant points on the flight path. For purposes of film-based research simulation, the brightness and contrast measurements should be taken from the filmed imagery, probably using a microdensitometer or some similar instrument.

Alternative contrast measures should be explored with the goal of attaining a linear relationship and higher correlation with the dependent variable.

e. Psychophysical Measures. The results of this project have demonstrated that perceptual target or target/background dimensions can be measured very reliably. The two problems here are selection of the dimensions to be measured and selection of the scenes in which these dimensions should be measured. The low correlations of the complexity and ambiguity scales measured here with acquisition performance indicate that one or both of these problems are present in the two scales.

The questions asked of the subjects in this project were "In which of the two scenes would it be easier to find targets?" (Complexity) and "How many cues or target-like objects are there in the scene?" (Ambiguity). Visual complexity or scene heterogeneity have not been directly addressed. Further, the count of possible target-locating cues and the count of target-like objects should be separated because they must operate in opposite directions; cues help and target-like objects detract from acquisition performance. The distinction between target-free and target-specific dimensions should be raised with regard to each of these scales, and if a scale addresses target-specific dimensions, then subjects should be briefed on the target.

The selection of scenes on which to measure these psychophysical dimensions may vary from dimension to dimension. Simultaneous goals should be minimizing the number of scenes while adequately representing the target approach area. A related problem is the decision of whether to use equal range increments or equal MAR proportions.

f. Static Detection Study. Following MAR, the strongest predictor of dynamic acquisition performance was the equivalent range measure from the Static Detection Study. It is recommended that this measure be used in future work, but that constant range rather than constant MAR intervals be used. This would allow direct comparability of detection time across targets.

g. <u>New Dimensions</u>. It is recommended that targets for which the predicted ranges were particularly inaccurate be studied. Identification of the reasons for the inaccurate predictions should lead to a discovery of new variables important in predicting acquisition performance.

h. <u>How to Proceed</u>. It is recommended that the candidate improvements suggested here be explored between the completion of this report and the application of the methodology to the SEEKVAL IB2 study. A large portion of this work can be done by further analytic work on IA2 data, while some may require small new data collection efforts using the IA2 imagery.

APPENDIX 1

ANNEX A

SUBJECTS' INSTRUCTIONS AND WRITTEN MATERIALS

1. CONTENTS OF THIS APPENDIX. Contained in this appendix are transcripts of oral and written materials given the subjects in the four studies of this project.

Tab A contains instructional materials used in the Dynamic Imagery Experiment. These include the Introduction, the General Instructions and Ground Rules, and the briefing material for the familiarization flight and six test flights.

The information given for the familiarization flight includes a description of Condition Zero, the Flight Plan for Mission Zero, the Mission Zero briefing, the Mission Zero Preflight Taped Comments, and the Mission Zero Inflight Events and Commentary.

As briefing materials for each test flight, the subjects were given the condition description and the mission description appropriate for that flight. Just prior to beginning the first test flight, each subject was read the Target Designation Review. All of the above are included in this Appendix, as well as summaries of mission events and transcripts of the FAC Commentary. Also given the subjects, but not included here, were the Flight Plan, and when appropriate, the book of vertical and forward oblique photographs.

Tab B gives the instructions used in the Complexity Study. A General Briefing, a set of Ground Rules, and the specific instructions for subjects are included.

The Ground Rules and specific instructions to subjects for the Ambiguity Study are presented in Tab C. The General Briefing used in that study was the same as the one presented in Tab B.

Tab D contains the instructions used in the Static Detection Study. In addition to those presented here, subjects were also given books of target briefing photographs and verbal target descriptions. The descriptions of targets were taken from those used in the Dynamic Imagery Experiment.

TAB A

APPENDIX 1

ANNEX A

DYNAMIC IMAGERY EXPERIMENT INTRODUCTION

Live: Good (morning, afternoon) gentlemen, I am __________ and these are _________ and __________. We will be with you the next two days during your work here. In order to maintain standard conditions, the rest of this introductory material and most of your later briefings will be taped or written.

From tape recorder: I would first like to give you a brief overview of the SEEKVAL program and its objectives, then we will move on to your specific instructions.

This experiment is one portion of a large scale effort entitled "Operational Test and Evaluation of the Capability to Acquire Targets in Combat Air Support". A $6 million, two-year series of simulator and laboratory tests, later to be validated by field trials, will be used to develop a predictive capability for the design and operation of more efficient air-to-ground systems.

Lt. General Glenn A. Kent states in a Department of Defense memorandum that "Acquisition of targets on the ground by observers in combat support aircraft is a complex problem. It involves a large number of factors relating to targets and their backgrounds, the atmosphere, and the characteristics of the acquisition systems themselves. All of these factors are known to affect target acquisition under one or more conditions. Consequently, a program to evaluate the effectiveness of devices for enhancing acquisition in an operational environment based solely on field testing would require extensive resources.

Also, there are problems in instrumenting a field test and obtaining meaningful results in such a test. Accordingly, a program based on simulations, validated by limited field tests, appears to be the best avenue of approach ..."

Essential to this approach is the development of qualified test data for each of the factors affecting acquisition performance. You have been selected to participate in one of these studies.

Today and tomorrow, you will take six flights, each under a different condition. Conditions will vary by speed, briefing materials, and in-flight cueing. On each flight, your primary task will be to search for and find an IP and 4 targets.

Prior to each of your simulator flights, you will receive a mission briefing. The briefing will describe the flight course, the Initial Position (IP), and the four targets to be acquired. Following each briefing, you will have a period to study and plan for the ensuing flight.

In these test flights, we will be interested in three principal measures of your performance at each target.

- First, whether or not you acquire the target;
- Second, the range at which you acquired the target;
- Third, whether or not you "acquired" non-targets.

In our data analysis, these three measures are combined into a single score so, in your search for each target, try to give equal importance to acquiring the correct target and to acquiring it at long range.

As with any aircraft flight operation, flight planning is of great importance to success. Detailed study and planning is essential in these operations since you will be traveling at high speed; you will not be able to look back over your shoulder and you will not be able to orbit while you figure out where you are. You will be strictly on your own, and you will have only a one-shot chance at each target.

A final comment regarding your participation in this study. While, like all the other participants in this study, you are a qualified air crewman, the quantity and quality of that experience will vary broadly among you. It is not certain whether or not that difference in background affects target acquisition performance significantly. We do know, however, that regardless of flight experience, the attitude and the effort put into the problem does weigh significantly. With these factors in mind, we encourage you to follow the instructions, use the materials provided, plan each flight carefully, and give us your best performance.

DYNAMIC IMAGERY EXPERIMENT

GENERAL INSTRUCTIONS AND GROUND RULES

The purposes of this experiment require the use of only a few of the aircraft flight instruments or controls. Thus, most of the instruments and controls in the simulator cockpit will be inactive. Lighting controls, an elapsed time clock, the interphone and the button on the top of the Bullpup controller will be operable and you will be instructed on their use during this briefing and the familiarization flight.

Before we begin the detailed briefing for Mission Zero, there are some ground rules and suggestions:

Ground Rule 1 -- In each flight, you will be required to search for four targets. Targets will always be far enough apart so that you need search for only one at a time. Your task will be to acquire the target and designate it at the greatest possible range.

Target acquisition responses will always be made by first pressing the button on the top of the Bullpup controller and then orally reporting its clock position relative to your aircraft.

Ground Rule 2 -- In each mission, you will also be assigned an Initial Position (IP). This is a major navigation checkpoint and should be used as the first place to check your elapsed time clock. We ask that you search for and designate the IP just as you would a target.

Ground Rule 3 -- In each flight briefing, you will be given aircraft speed and the time and distance from mission start to the IP and assigned targets. All speeds will be given in knots, and they are accurate to 5% as given. Distances will be given to the nearest half nautical mile. Times have been computed as the distance flown divided by the speed given, and are stated as minutes plus seconds.

Ground Rule 4 -- During each briefing, you will be given a chart folderfor that mission. The folder contains, first, mission area coverage in 1:250,000 scale topographic maps and, second, more precise track coverage in 1:50,000 scale pictomaps. A four mile wide corridor is shown on all maps and you will always be somewhere in that corridor. The 1:50,000 coverage is continuous in the sense that the top of one chart adjoins the bottom of the next. As much as possible, all maps are oriented heading up.

You may take the chart folder into the cockpit with you, so you are encouraged to make mission planning notes in grease pencil on the plastic covered charts or on the facing blank pages.

Ground Rule 5 -- Please do not discuss the missions, the targets or the procedures with others who may be participating as air crewmen in this experiment. If you have heard talk of the missions or targets, please inform the briefing officer. After completing a flight, we ask that you refrain from any discussion or comments about the flight if other test air crewmen are present.

In addition to the formal ground rules, there are several techniques we suggest that you employ to exploit available briefing materials.

Suggestion 1 -- To maintain better geographic orientation along the track, additional navigational checkpoints should be selected. These will be for your own reference and you will not be required to report their acquisition. You will have to measure distances and calculate times for these intermediate checkpoints and note them in your flight planning charts.

Suggestion 2 -- You have an elapsed time clock in the cockpit. It is suggested that you use total elapsed times from the first air-to-ground scene you see, and note these on your planning charts. Then, start the clock at the first scene and use it to check your progress through the flight.

Condition Zero

In this mission your speed will be 360 knots. The following briefing materials will be available to you:

(1) Verbal track-, IP-, and target descriptions, and

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:62,500 scale pictomaps.

In addition, a range-to-go indicator will be operating during this mission. This indicator will present you with the distance from present position to the target nadir/abeam position. Indications are in 100's of feet. The display will operate and reset automatically; you should not manipulate the controls on the range-to-go indicator.

Further inflight assistance will be provided during this familiarization mission by a flight correlated voice-tape recording.

Subject______

Mission   0

SEEKVAL FLIGHT PLAN

AUTOMATIC TERRAIN FOLLOWING at 200 feet, 360 KIAS.

Winds: light, variable; Visibility 15+ miles.

IP/TGT	NAME	APPROACH HEADING	CUMULATIVE		REMARKS
			DISTANCE	ETE	
IP	Dam Control Tower	146T	5.2	0 + 52	
TGT 1	Highway Bridge	141T	11.9	1 + 59	
TGT 2	Omni Station	178T	22.5	3 + 45	
TGT 3	SAM Site	161T	39.8	6 + 38	

Figure 1-A-1

DYNAMIC IMAGERY EXPERIMENT

MISSION ZERO BRIEFING

Your first simulated flight (called Mission Zero) will be a low-altitude mission, 39.8 NM long, with automatic terrain following at a mean altitude of 200 feet above ground level. Aircraft speed will be 360 knots. Winds are variable to 10 knots and visibility is in excess of 15 miles.

The purpose of this initial mission is to familiarize you with the simulator and our experimental procedures. Mission objectives will be the acquisition of one initial position (IP) and three targets. Although a voice tape recording and range-to-go indicator will be available to you during your initial flight, you will have only your own premission planning to guide you during some subsequent flights and you will not have the benefit of additional inflight information beyond use of the elapsed time clock. Please do your mission planning accordingly for this flight.

Mission Zero begins approximately 4 miles northwest of Wister, Oklahoma on an initial base course of 146°T. You will proceed 5.2 NM to IP-0.

IP-0 is the Wister Dam Water Control Tower, located 8 nautical miles southwest of Poteau, Oklahoma. The tower is located at the south end of the dam which is earthen, and controls the flow of water out of Lake Wister into the Poteau River. The tower is of concrete construction and measures approximately 25 meters wide, 10 meters thick, and 23 meters high. The approach to the control tower is over Lake Wister.

After passing IP-0 you will change base course left to 141°T and proceed 6.7 NM to Target 0-1. Shortly before reaching Target 0-1 a right heading correction to 178°T will be made.

Target 0-1 is the highway bridge over the Poteau River, 2 nautical miles southwest of Heavener, Oklahoma. The bridge is on U.S. Highway 270/50, which is oriented north and south. The river generally is oriented east and west. The bridge is a through-type with overhead steel truss. The deck is concrete with asphalt topping. The dimensions are 5 meters wide and 110 meters long. The overhead truss is painted silver. There are two short spans with supporting piers at each end of the bridge and no supporting pier in the center span. The approach to the bridge and both river banks are heavily wooded. A single-track railroad bridge with black overhead truss crosses the river approximately 200 meters east of the highway bridge.

After passing target O-1 you will make a slight course correction to the left and proceed 10.6 NM to Target O-2.

Target O-2 is the OMNI Station located 4 miles southwest of Page, and 12.5 miles south of Heavener, Oklahoma. The station consists of a small square building topped by a large disk, and nose-cone shaped antenna in the center of the disk. The entire structure is approximately 10 meters high and is painted white. The station sits in a clearing on 2,693-foot ridge. A gravel access road approaches the station from the east.

At Target O-2 you will turn left to a heading of 161°T and proceed 17.3 NM to Target O-2.

Target O-3 is a surface-to-air missile (SAM) site located 4 miles west-southwest of Cove, Arkansas. The site contains the following elements: six missiles poised on launchers (these launchers are in small revetments), one guidance radar with a 5-meter solid horizontal antenna, a 5-meter solid vertical antenna, and a 2-meter parabolic dish antenna. These antennas are mounted on a 6-meter van, seven truck vans, and three generator trailer vans. The missiles are silver in color, while all other equipment is olive drab. The site itself is within an area approximately 200 by 125 meters. The site is located in a large open field with timbered areas on three sides.

Shortly after passing Target O-3, the flight will be terminated.

DYNAMIC IMAGERY EXPERIMENT

MISSION ZERO PREFLIGHT TAPED COMMENTS

Prior to Film Start - Hello, welcome to the Boeing Multimission Simulator. Prior to starting your first simulated flight, I would like to point out some of the things in the cockpit which you will need to use during this and subsequent missions. These comments are taped to assure that all our subjects start their tasks with the same information regarding our procedures. If any questions should arise during the mission, please discuss them with the test engineer or briefing officer after we have terminated this flight.

The current experiment deals with target acquisition performance without the task loading of flight control tasks, and none of the flight instruments, controls and/or avionics will be activated during any of your missions. Thus, you can assume automatic terrain following and avoidance, auto-throttle, and auto-navigation.

To enable you to check your flight progress relative to your flight plan and cartography, an elapsed time clock is provided above the right side of the glare shield. Pressing the button on the lower right hand corner of this clock should result in start, stop, reset in that order. We would like you to use the clock for total elapsed time measurement only and to plan your flights accordingly. Start your clock as the first air-to-ground scene appears upon the projection screen, which will be 3 to 6 seconds after you hear the projector start running. The digital display mounted on top and in the middle of the glare shield is a range-to-go indicator which will be programmed for Mission 0 and one other mission to provide you with distance in feet to the IP and each target. The display counts down from a preset distance in 100s of feet such that the "units" and "tens" digits will always read "0". The range-to-go indicator will be preset by the test engineer. The only adjustment you should make is the display brightness-level you prefer. Other cockpit lighting is controlled by the knobs on the [illegible] side panel, for the instrument lights, and by adjusting the back knob on the map lights mounted on each side on the upper cockpit frame.

Communication with the test engineer will be by open mike and headphone in a similar manner to what you are experiencing presently.

Mounted on the left side of the seat toward the front is a small hand controller with a button on top. This is normally the Bullpup controller, but the top button will be used in the present experiment for your designation of acquired targets.

At this point let me talk briefly about the procedures for acquisition and designation of targets.

Target acquisition is the process whereby the aircrew searches and detects various objects, inspects these objects, and then decides that one of them is actually the target. The event button will be used to designate this acquisition decision for the IP and each of the assigned targets. Each of the following must be observed in your designation of all prebriefed items:

(1) You should attempt to acquire and designate all assigned items as early as possible; that is, at the greatest possible distance. This means that the event button must be pressed at the instant you reach your decision.

(2) Your designation must be made only to a specific assigned object, and never to the general locale where it is expected to occur. In other words, you should press the event button only after you have a direct line-of-sight to the target element. On occasion you may observe various cues that lead you to expect the target to occur. Your designation, however, must be reserved until a direct line-of-sight has been established with the assigned object.

(3) After you have activated the event button to designate each prebriefed item, identify the object acquired and its location over the interphone system.

(4) You may press your event button to indicate acquisition, then discover that you have made a mistake. In that case, press your event button again when you acquire the real target. Although you cannot erase the error, your acquisition performance on the real target will be scored.

(5) Targets and checkpoints are occasionally missed entirely, even by highly practiced observers. You should prepare yourself during flight planning to recognize as early as possible when a target has been missed so that performance on future targets will not be jeopardized.

This concludes our preflight comments. If you have any questions at this point, please communicate with the test engineer over the interphone now, and then let him know when you are ready to start your flight.

DYNAMIC IMAGERY EXPERIMENT

MISSION ZERO (FAMILIARIZATION FLIGHT)

INFLIGHT EVENTS AND COMMENTARY

TIME	EVENT
0-03	Comment: "Remember to start your clock as the first scene appears on the screen."
0+00	First scene appears.
0+02	Range-to-go display starts counting down on the IP.
0+02	Comment: "You are traveling at the rate of one nautical mile per ten seconds. To get an idea of range estimation at this speed, select an item in the field of view and see how long it takes to pass below the aircraft. ETA at the IP, the Lake Wister Dam Control Tower, is 0+52. The range-to-go indicator is counting down the last 30,000 feet to the IP. Try to follow the instructions you just heard in acquiring and designating the IP and targets."
0+34	IP first visaully available.
0+36	Comment: "As you approach the assigned area, place your hand on the designation handle and be prepared to press the event button as soon as you decide that you see the target. Do not worry about the verbal reporting of the target location until you have pressed the event button. Press the event button again as you pass over or abeam of the target to confirm your acquisition response."
0+52	On top IP.
0+56	Comment: "Contextual cues are anything in the visual scene that you might use to direct your search to a particular area. You should not designate acquisition on the basis of such cues. Wait until you can actually see some element of the target itself. The lake and earthen dam, in relation to the control tower we just passed, are examples of contextual cues. Target 1 is the highway bridge over the Poteau River. ETA at the bridge is 1+59. The highway is oriented north and south and the river is generally oriented east and west. The bridge dimensions are approximately 5 meters wide by 110 meters long. The bridge is

a through-type with a silver painted overhead steel truss. The approach to the bridge and both river banks are heavily wooded. The target appears shortly after passing a low ridgeline. A single-track railroad bridge approximately 200 meters east of the highway bridge is not part of the assigned target."

1+32 Range-to-go display starts counting down on Target 1.

1+51 Target 1 first visually available.

1+59 On top Target 1.

2+00 Comment: "ETA at the next target, the OMNI station, is 3+45. Try to use the information available from the range-to-go indicator to find this target. Targets and IPs are occasionally missed entirely, even by practiced observers. You should be prepared to recognize when you have missed one. Your total-elapsed-time clock should help you recognize when you have missed a target. If it should happen that you indicate an acquisition, but then see something you think more likely to be the assigned item, you should make an acquisition designation to the second item just as if you had not made the mistake on the first designation. The question of how much of the target you must see to reach an acquisition decision is largely up to you. You should be reasonably sure that an object is the target. To be absolutely certain is perhaps being overly conservative. A valid interpretation of reasonably certain would allow designation when some object simply looks more like the target than anything else in the field of view."

2+47 Range-to-go display starts counting down on Target 2.

3+29 Target 2 first visually available.

3+45 On top Target 2.

3+50 Comment: "ETA at the last target, the SAM site, is 6+38. To familiarize you with conditions in which you will have no inflight assistance, the range-to-go indicator will be inoperative for this target and we will terminate the taped comments now. Remember to press the designation button at the instant you decide you have acquired the target and again when you pass over or abeam of the target."

6+19 Target 3 first visually available.

6+38 On top Target 3.

6+52 End of Mission 0.

DYNAMIC IMAGERY EXPERIMENT

TARGET DESIGNATION REVIEW

"While, operationally, you might sometimes commit to deliver ordnance before you actually see the target, here we would like you to wait until you see some element of the target itself. How much of the target you must see to reach an acquisition decision is largely up to you. You should be reasonably certain that the object you see is the target you are looking for. To be absolutely certain is, perhaps, being overly conservative. A valid interpretation of 'reasonably certain' would allow designation when some object looks more like the target than anything else in the field of view.

Now, to review the designation procedure: As soon as you have acquired a target or IP, press the button once and tell me its clock position. Press the button again and tell me when the target passes out of view. If you designate the wrong item and then find the right target, pickle on the right one when you find it and when it disappears. I will "roger" your transmissions for each target after it passes.

DYNAMIC IMAGERY EXPERIMENT

CONDITION 1

In this mission, your speed will be 360 knots. The following briefing materials will be available to you:

(1) Verbal track-, IP- and target descriptions, and

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps.

In addition, the range-to-go indicator will be operating during the flight. As you recall, this indicator will show you feet-to-go from present position to the target nadir/abeam position. It will operate and reset automatically; you should not manipulate the controls on the range-to-go indicator.

The FAC will not be assisting you in this mission.

CONDITION 2

In this mission, your speed will be 360 knots. The following briefing materials will be available to you:

(1) Verbal track-, IP- and target descriptions, and

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps.

In addition, you will be cued on target location during the flight by simulated FAC radio transmissions. The FAC will describe the IP and each target and will give you lead-in cues as you approach each target area.

The range-to-go indicator will not operate in this mission.

CONDITION 3

In this mission, your speed will be 360 knots. The following briefing materials will be available to you:

(1) Verbal track-, and IP- and target descriptions, and,

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps.

The FAC will not be assisting you in this mission. The range-to-go indicator will not operate in this mission.

CONDITION 4

In this mission, your speed will be 220 knots. The following briefing materials will be available to you.

(1) Verbal track-, IP- and target descriptions, and

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps.

The FAC will not be assisting you in this mission. The range-to-go indicator will not operate in this mission.

CONDITION 5

In this mission, your speed will be 360 knots. The following briefing materials will be available to you:

(1) Verbal track-, IP- and target descriptions, and

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps, and

(3) Forward oblique and vertical photographs of the IP and each target. The approach angle shown in the forward obliques may or may not correspond to the one you will encounter during your mission/flight. The approach heading to each target is indicated on the vertical photograph of that target. You are urged to study these photographs, but you will not be permitted to take them into the cockpit with you. In these photographs, some of the target elements may be missing but the areas marked by rectangles are where you can expect to find them during the mission.

The FAC will not be assisting you in this mission. The range-to-go indicator will not operate in this mission.

CONDITION 6

In this mission, your speed will be 220 knots. The following briefing materials will be available to you:

(1) Verbal track-, IP- and target descriptions,

(2) Complete map coverage in 1:250,000 scale topographic maps and 1:50,000 scale pictomaps, and

(3) Forward oblique and vertical photographs of the IP and each target. The approach angle shown in the forward obliques may or may not correspond to the one you will encounter during your mission/flight. The approach heading to each target is indicated on the vertical photograph of that target. You are urged to study these photographs, but you will not be permitted to take them into the cockpit with you. In these photographs, some of the target elements may be missing but the areas marked by rectangles are where you can expect to find them during the mission.

The FAC will not be assisting you in this mission. The range-to-go indicator will not operate in this mission.

DYNAMIC IMAGERY EXPERIMENT

MISSION 1 DESCRIPTION

Mission 1 is a low-level penetration, 49 nautical miles long, at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission, the navigation system of your aircraft has been programmed to fly a zigzag course between assigned targets. The pattern is essentially random but you will always be within the flight corridor marked on the charts.

Mission 1 begins 5 miles south -southeast of Smithville, Oklahoma, on an initial heading of 220° True. You will proceed 3.6 NM on that heading, then turn in the vicinity of a fire lookout tower to 283° True to Initial Position (IP) 1.

IP-1 is an orange marker located 1.5 miles west of Battiest, Oklahoma. The marker is an organge pyramidal pylon in an open field about 15 meters south of a two-lane paved road, equidistant between a road intersection and a two-lane bridge over Silver Creek.

At IP-1, you will correct base course to 287°T and proceed 12.7 NM to Target 1-1.

Target 1-1 is a medium antiaircraft battery located 1 mile south of Nashoba, Oklahoma. The target is composed of 6 gun positions arranged around the periphery of a 70-meter diameter circle. Each position is a 7-meter diameter revetment. Three of the revetments are empty and three contain 56 mm AA guns. The site is in a small clearing beside a gravel road. Approach to the target is over heavy forest.

In the vicinity of Target 1-1, base course will change left to 277°T, and you will fly 5.8 NM to Target 1-2.

Target 1-2 is a 152 mm howitzer battery located 5.5 miles west of Nashoba, Oklahoma. The howitzer battery is composed of 6 revetted positions deployed in a row. Each revetment is 10 meters across and they have 30 meter separations. Four of the positions are occupied by self-propelled howitzers. The guns are pointed north-northeast. The target site lies in an open brown field on the north side of Highway 271 and is served by a sand road. Heavy vehicle tracks are visible along the revetment row.

In the vicinity of Target 1-2, base course will change right to 305°T and proceed 8.5 NM to Target 1-3.

Target 1-3 is a pontoon bridge across the Kiamishi River, 1/4 mile southeast of Stanley, Oklahoma. The bridge is approximately 45 meters long and is comprised of 10 pontoons supporting a single-lane roadway pointed north-south. From either end of the bridge, the road leads into lightly wooded areas. Final approach to the target area is along the Kiamishi River.

In the vicinity of Target 1-3, base course will change left to 280°T and you will fly 2.7 NM to Target 1-4.

Target 1-4 is a row of 6 howitzers located 2.5 miles west of Stanley, Oklahoma. The 122 mm howitzers are in 10-meter diameter revetments in an open field, spaced about 30 meters apart along a row oriented northwest-southeast. Six 2½ ton trucks, the prime movers for the howitzers, are parked along a sand road beyond the row of guns. Target elements are painted olive drab and are moderately visible against the background.

Mission 1 will end just beyond Target 1-4.

DYNAMIC IMAGERY EXPERIMENT

MISSION 2 DESCRIPTION

Mission 2 is a low-level penetration, 45.0 NM long, at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission, the navigation system of your aircraft has been programmed to fly a zigzag course between assigned targets. The pattern is essentially random, but you will always be in the flight corridor marked on the charts.

Mission 2 begins 3.3 miles east-southeast of Adel, Oklahoma, on an initial base course of 278°T. You will proceed 7.3 NM to Initial Position (IP) 2.

IP-2 is the dirt airstrip located 4.5 miles west-southwest of Adel, Oklahoma. The strip is 800 meters long and 30 meters wide. Runway heading is 045°T. The north end of the runway is 215 meters south of an intersection between two paved roads. A tent and five large vehicles are located in a parking area southeast of the runway center. The dirt strip is in a rectangular grass clearing bounded on three sides by groves of trees.

At IP-2, you will change base course right to 294°T and proceed 4.9 miles to Target 2-1.

Target 2-1 is a vehicle park located 4 miles north of Daisy, Oklahoma. The target is composed of 12 armored personnel carriers, two 2½ ton trucks and two jeeps. All vehicles are olive drab in color and are haphazardly positioned in a 150 by 150 meter area. The vehicles are assembled 60 meters west of a hard surface road in an open field, and tracks are clearly visible.

After passing Target 2-1, base course will change twice to the left to 244°T and 112°T. The length of the legs varies, but the total distance flown from Target 2-1 to Target 2-2 is 20.7 NM.

Target 2-2 is a petroleum, oil and lubricant (POL) site located 35 miles southeast of Chockie, Oklahoma. Three hundred 55-gallon drums are stacked in 2 rows on either side of an improved dirt road. A flatbed truck and a jeep are parked at the site. The drum stacks are 30 meters long, 3 drums high, and are parallel to the road. The site is in a large open area. Target elements are painted olive drab and are difficult to see against the dark field.

In the vicinity of Target 2-2, base course will change to 180°T and you will proceed 6.5 NM to Target 2-3.

Target 2-3 is a heavy (203 mm) howitzer battery located 1 mile northeast of Redden, Oklahoma. The site consists of 2 self-propelled howitzers pointed north in open revetted positions 35 meters apart. The revetments are in an eastwest line, and the site is centered 45 meters west of a gravel road. An armored personnel carrier is also included in the target. There are no trees in the immediate vicinity of the target area. Earth scars from the revetments and heavy interconnecting tracks stand out from the open green field.

After passing Target 2-3, base course changes right to 116°T and you will proceed 4.6 NM to Target 2-4.

Target 2-4 is an occupied helicopter pad located 5 miles east-southeast of Redden, Oklahoma. Two light helicopters are parked 100 feet apart. The pad is about 30 meters south of an improved dirt road and about 30 meters further south is a stack of 55-gallon POL drums. The site is in an open field and no tracks or earth scars are immediately visible.

Mission 2 ends after you pass Target 2-4.

DYNAMIC IMAGERY EXPERIMENT

MISSION 3 DESCRIPTION

Mission 3 is a low-level penetration 36.0 nautical miles (NM) long at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission, the navigation system of your aircraft has been programmed to fly a zigzag course between assigned targets. The zigzag pattern is essentially random but you will always be in the flight corridor marked on the charts.

Mission 3 begins 1/2 mile north-northeast of Jumbo, Oklahoma, on an initial base course of 072°T. You will proceed 4.5 NM to Initial Position (IP) 3.

IP-3 is a storage area located 4 miles north-northwest of Eubanks, Oklahoma. Five stacks of supplies are placed in a roughly pentagonal pattern about 45 meters apart. A 2½ ton truck is parked in the area. The grey stacks and the olive drab truck are visible against the green field. The field is roughly rectangular, 215 by 150 meters, and surrounded by woods. A dirt road runs along the west (near) side of the field.

At IP-3, you will correct base course to 112°T and proceed 4.1 NM to Target 3-1.

Target 3-1 is a tank platoon located 1/2 mile northeast of Dunbar, Oklahoma. The platoon is composed of 4 tanks in partial revetments. The revetments are on an east-west line with 30 meters separation. The tanks are deployed in an open field between Highway 144 and the Kiamishi River. A dirt road serves the target area from the north side of the line of revetments, and earth scars from the revetments and interconnecting tracks are visible.

In the vicinity of Target 3-1, base course will change to 138°T and you will fly 3.8 NM to Target 3-2.

Target 3-2 is an anti-tank battery located about 4.5 miles east of Eubanks, Oklahoma. Two towable anti-tank guns are located in revetments 40 meters apart and two 1/2 ton trucks are parked near the revetments. The site is in a roughly rectangular clearing in an otherwise heavily wooded area. Earth scars are visible but do not stand out well against the green field.

In the vicinity of Target 3-2, base course will change to 108°T and you will fly 4.0 NM to Target 3-3.

Target 3-3 is a FROG (free rocket over ground) site located 0.5 miles north of Snow, Oklahoma. Four 2½ ton trucks and a SS missile on its launcher are parked about 45 meters apart in a roughly pentagonal array. A jeep is parked near the launcher. The target is in an open field east of U.S. Highway 271. Heavy tracks to the vehicle locations are visible. All target elements are painted olive drab.

In the vicinity of Target 3-3, base course will change to 103°T and you will fly 14.4 NM to Target 3-4.

Target 3-4 is a surface-to-air (SAM) missile site located 7.5 miles south-southeast of Nashoba, Oklahoma. The site contains the following elements: 6 missiles on partially revetted launchers, 7 truck vans, 3 generator vans and a van-mounted radar array. The missiles are silver and all other target elements are painted olive drab. The missiles are located around the periphery of a 215 by 170 meter clearing with the other elements grouped in the center of the clearing. Access tracks join the various target elements. The site is in an isolated clearing in an otherwise heavily wooded area.

Mission 3 will end just beyond Target 3-4.

DYNAMIC IMAGERY EXPERIMENT

MISSION 4 DESCRIPTION

Mission 4 is a low-level penetration, 38.5 NM long, at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission, you will follow highways and roads a large part of the time. Departures from the roads will be made when the turns are too abrupt and to change from one road to another.

Mission 4 begins at Eagletown, Oklahoma on an initial base course of 230^{O}T. Shortly after the beginning, you will come to 271^{O}T and fly for a total of 3.6 NM to Initial Position (IP) 4.

IP-4 is a prominent water tower serving an industrial complex. The complex consists of a number of large one-story buildings in a large paved area. Surrounding terrain is heavily wooded except for a waste treatment facility which serves the plant and is located 0.5 NM east of the primary complex.

At IP-4, you will continue on base course 271^{O}T, then turn in the vicinity of Broken Bow, Oklahoma to 299^{O}T and proceed to Target 4-1. The total distance from IP-4 to Target 4-1 is 8.2 NM.

Target 4-1 is a tank convoy located 2 miles west-northwest of Broken Bow, Oklahoma. Five medium tanks are parked on the south shoulder of Oklahoma Highway 7, with 100 meters separation. The tanks are painted olive drab and are visible against the dirt shoulder.

Passing Target 4-1, you will continue on base course 299^{O}T, flying 2.6 NM to Target 4-2.

Target 4-2 is a vehicle park located 5 miles west-northwest of Broken Bow, Oklahoma. Thirteen 2-1/2 ton trucks are parked in a roughly rectangular 105 by 115 meter pattern just south of Oklahoma Highway 7. The site is almost clear of trees. The olive drab trucks and heavy track pattern are visible against the green field grass.

Passing Target 4-2, you will continue on base course 299^{O}T, flying 8.4 NM to Target 4-3.

Target 4-3 is a surface-to-air missile (SAM) site located 13 miles west-northwest of Broken Bow, Oklahoma. The site includes four revetted missile launchers with two missiles each placed in an open field placed on an east-west line with about 20 meter spacing. In a lightly wooded

area about 90 meters south of the row of launchers, there is a group of associated vehicles including two 2-1/2 ton trucks, two generator trailers and a guidance radar van. The missiles are painted silver; the other target elements are olive drab and heavy earth scars are visible.

Passing Target 4-3, you will continue on base course 299°T for 8.7 NM and then base course will change to 271°T and you will fly 6.7 NM to Target 4-4.

Target 4-4 is an anti-aircraft machine gun unit located 1/2 mile northwest of Sobol, Oklahoma. Two quad 50 caliber machine guns are located in revetments 20 meters apart. They are in an open field 30 meters north of Oklahoma Highway 7. The olive drab gun mounts and the earthen revetments are visible against the green field.

Mission 4 will end shortly after you pass Target 4-4.

DYNAMIC IMAGERY EXPERIMENT

MISSION 5 DESCRIPTION

Mission 5 is a low-level penetration, 41.5 NM long at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission you will follow highways and roads a large part of the time. Departures from the roads will be made when turns are too abrupt and to change from one road to another.

Mission 5 begins 1.6 miles east of Corrine, Oklahoma on an initial base course of 271^{o}T. You will fly that base course for 1.4 NM, then change base course to 330^{o}T for the remaining 1.6 NM to Initial Position (IP) 5.

IP-5 is a "Y" road junction 1.5 miles northwest of Corrine, Oklahoma. Approach is along Oklahoma Highway 7 which is joined at 4 o'clock by a dirt secondary road. Several farm buildings are visible near the intersection.

At IP-5, you will continue on base course 271^{o}T for 1.5 NM to Target 5-1.

Target 5-1 is a medium AA battery located 1/2 mile east of Corinne, Oklahoma. The site is composed of a circle of 6 revetments with 4 occupied by 57 mm towable AA guns. Northeast of the gun positions are two more revetments, one containing a fire control director and the other with a van-mounted fire control radar. All target elements are painted olive drab and there are a number of trees in the immediate target area. The battery occupies an area 70 by 85 meters, centered about 110 meters south of Oklahoma Highway 7.

Passing Target 5-1, you will continue on base course 271^{o}T for 2.7 NM to Target 5-2.

Target 5-2 is a surface-to-air missile (SAM) convoy located 1 mile east of Rattan, Oklahoma. Three missiles on transporters are parked on the north shoulder of Oklahoma Highway 7 with 100 meter separations. The missiles are painted silver and are visible against the darker dirt shoulder.

After Target 5-2, you will fly three legs to Target 5-3. You will fly first 271^{o}T, then 312^{o}T and finally 281^{o}T for a total of 19.5 NM between Targets 5-2 and 5-3.

Target 5-3 is a truck convoy located 1/2 miles west of Darwin, Oklahoma. Seven vehicles - a jeep, four 2-1/2 ton trucks and two 10 ton trucks with trailers - are parked on the north side of Oklahoma Highway 7 with 100 meter separation. The olive drab vehicles are visible against the road shoulder.

After Target 5-3, you will fly three legs to Target 5-4. Your base courses will be 284°T, then 183°T, finally 092°T for a total of 13.3 NM to Target 5-4.

Target 5-4 is a heavy anti-aircraft machine gun battery located in the vicinity of Nelson, Oklahoma. It is at the northeast corner of an intersection of two improved dirt roads. The target is in a cloverleaf pattern of four revetments with 20 meter separation between positions. Three of the positions are occupied by quad 50-mm machine guns. The target is in a large clear field and occupies an area 35 meters square. The scarred cloverleaf pattern formed by the earth revetments is visible against the green field grass. Mission 5 will end shortly after Target 5-4.

DYNAMIC IMAGERY EXPERIMENT

MISSION 6 DESCRIPTION

Mission 6 is a low-level penetration, 45.0 NM long, at a mean terrain clearance altitude of 300 feet. Winds are variable to 10 knots and visibility is in excess of 15 miles. In this mission, you will follow highways and roads a large part of the time. Departures from the roads will be made when turns are too abrupt and to change from one road to another.

Mission 6 begins 1/2 mile west of Kent, Oklahoma on an initial heading of 092°T. You will continue on this heading for 2.8 NM, then follow roads along the general base course of 113°T to Initial Position (IP) 6. The total distance from the start of Mission 6 to IP-6 is 16.0 NM.

IP-6 is a blue-roofed school house in the town of Sawyer, Oklahoma. It is one block north of U.S. Highway 70 and two blocks north of a single railroad line which may contain a freight train.

At IP-6, you will follow U.S. Highway 70 for 2.3 NM on a base course of 064°T, then come right to 098°T for the remaining 6.8 NM to Target 6-1. The total distance from IP-6 to Target 6-1 is 9.1 NM.

Target 6-1 is a surface-to-air missile (SAM) convoy located 1/2 mile east of Swink, Oklahoma on the south shoulder of U.S. Route 70. The target convoy consists of 3 SA-2 missiles on transporters. There are 100 meter separations between the transporters which are parked between the road and the railroad track. The missiles are painted silver and stand out well against the grass on which they are parked.

After Target 6-1, you will follow U.S. Highway 70 on a base course of 104°T for 7.0 NM to Target 6-2.

Target 6-2 is a battery of light anti-aircraft guns located 2 miles east of Swink, Oklahoma. Three 37 mm AA guns are emplaced in revetments separated by 35 meters. Communication trenches connect the three positions. The site is in an open field 15 meters west of a gravel road and 15 meters south of a single railroad track running parallel to U.S. Highway 70. The triangular pattern of guns and the disturbed earth of the trenches and revetments are visible against the green field.

After Target 6-2, you will continue to follow U.S. Highway 70 on a base course of 104°T for 1.7 NM, then 120°T for 1.7 more NM to Target 6-3.

Target 6-3 is a tank convoy located 1.5 miles southeast of Millerton, Oklahoma. Four medium tanks and a medium recovery vehicle are parked on the south shoulder of U.S. Highway 70, between the road and a parallel railroad track. Separation between vehicles is 100 meters. The vehicles are painted olive drab and are visible against the earth road shoulder.

After Target 6-3, you will continue to follow U.S. Highway 70 for 1.9 NM on base course 120^{o}T to Target 6-4.

Target 6-4 is a vehicle park located 1 mile northwest of Garvin, Oklahoma. The target consists of the following elements: seven 2-1/2 ton trucks, three of which are towing 122-mm howitzers; three armored personnel carriers, each towing a 122-mm howitzer; and two medium tanks. All units are painted olive drab and they are haphazardly parked in an area 100 meters square. The target area is in an empty green field and heavy vehicle tracks are clearly visible.

Mission 6 ends shortly after Target 6-4.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 1

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0+00	First scene appears.
0+24	FAC: "Targets for this mission are located in rolling heavily wooded terrain. Terrain elevation is from 500 to 1000 feet, with trees to 40 feet."
1+08	FAC: "The IP for this mission is an orange pylon marker located 5.4 miles south of a small town."
1+24	FAC: "When the small town appears at the 2 o'clock position, the pylon marker will then be at 12 o'clock."
2+33	FAC: "The town will pass at 2 o'clock."
2+47	FAC: "Pylon marker at 12 o'clock."
2+49	IP-1 first visually available.
3+12	On top IP-1.
3+56	FAC: "The first target is a medium AAA battery containing 57 mm guns. There are 6 revetted gun positions - 3 revetments are occupied. The target is located in a 150 meter radius clearing. All approaches to the target area are heavily wooded."
4+34	FAC: "The target is located on a ridge line."
5+09	FAC: "The target is at 12 o'clock."
5+11	Target 1-1 first visually available."
5+20	On top Target 1-1.
5+29	FAC: "The second target is a self-propelled howitzer battery. There are 6 revetted positions with 4 positions occupied. The revetments are 30 meters apart and are located in a large clearing

100 meters north of an east-west highway. There is a large white building 10 meters north of the same road which is approximately 300 meters prior to the target area."

6+10 FAC: "The target is at 12 o'clock."

6+11 Target 1-2 first visually available.

6+18 On top Target 1-2.

6+38 FAC: "The next target is a pontoon bridge. The bridge is 50 meters long and is oriented north-south across the river."

6+53 FAC: "The bridge is located approximately 150 meters south of an east-west road and railroad."

7+22 FAC: "The target will appear shortly after passing a ridge line."

7+36 FAC: "The target is at 12 o'clock."

7+38 Target 1-3 first visually available.

7+44 On top Target 1-3.

7+47 FAC: "Next target is a battery of towed howitzers. There are 6 revetted positions with revetments 30 meters apart. They are spaced in a large clearing near the mid-point of the clearing."

8+01 FAC: "The target is at 12:30."

8+03 Target 1-4 first visually available.

8+11 On top Target 1-4.

8+17 End of Mission 1.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 2

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0-01	FAC: "The targets for this mission are in gently rolling heavily wooded terrain. Terrain elevation is from 700 to 1000 feet, with trees to 40 feet."
0+00	First scene appears.
0+10	FAC: "The Initial Point from which we'll start the mission is a dirt airstrip located approximately 4 and 1/2 miles southwest of a small town. The runway is oriented northeast-southwest, and you'll find a large square plowed field just off the north end of the runway."
0+54	FAC: "The plowed field now is at the 12:30 position."
0+55	IP-2 first visually available.
1+14	On top IP-2.
1+19	FAC: "Our first target's going to be a vehicle park located west of a north-south road. The road makes a bend, and where it makes its bend, there's an access road that leads into the truck park. There are 16 vehicles in a random nature in a 300 meter range. At the back end of the clearing where the vehicle park is located the terrain makes a sharp rise."
1+54	Target 2-1 first visually available.
1+55	FAC: "Target area is at 12 O'clock."
2+04	On top Target 2-1.
2+10	FAC: "As we speed on toward Target 2 the first checkpoint we use will be a large TV relay tower which will pass off to the right side. The relay tower will appear just prior to a hard surface road which we'll cross, and then we'll be initiating a left turn of one of two left turns that will get us headed back towards Target 2."

2+52 FAC: "The TV tower is now at 12 o'clock at about 4 miles."

3+28 On top TV relay tower.

3+39 FAC: "After making this initial left turn I'll have you be making a second left turn and after which you roll out after the second left turn you'll be able to see a large body of water off the right wing. That checkpoint should locate you approximately 4 and 1/2 miles from the target.

4+41 FAC: "The next target is a POL storage area. You'll find the storage area located on the west side of a large clearing approximately 50 meters from a western tree line. The POL is oriented parallel to the tree line in a north-south manner, and also there's a small pond located approximately 300 meters south of the target area."

5+27 FAC: "Target area is at 12 o'clock."

5+28 Target 2-2 first visually available.

5+34 On top Target 2-2.

5+39 FAC: "The next target we're going after is a heavy howitzer battery. It's located 30 meters west of a north-south road. This road makes a series of 90 degree turns. As we approach the target area, a small cleared area will appear prior to the actual target area."

6+23 Target 2-3 first visually available.

6+26 FAC: "Target is at 12 o'clock."

6+39 On top Target 2-3.

6+39 FAC: "Our last target is a heli pad. We've got 2 choppers on the pad parked about 20 meters apart. The choppers are midway between two north-south roads 30 meters south of an east-west road, the road which connects these 2 roads. The target area will appear shortly after we pass a series of 3 ridge lines."

7+17 FAC: "The target area is coming up now at 12 o'clock low."

7+18 Target 2-4 visually available.

7+25 On top Target 2-4.

7+31 End of Mission 2.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 3

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0+00	First scene appears.
0+03	FAC: "The targets for this mission are located in wooded rolling terrain. Terrain elevation is 500 to 1000 feet, with trees up to 40 feet. The IP from which we'll start this mission is a storage area located in a rectangular clearing of approximately 500 by 300 meters in a heavily wooded area. There's a dirt road that runs north and south on the west side of the clearing."
0+30	FAC: "The IP is at the 12 o'clock position."
0+38	IP-3 first visually available.
0+43	On top IP-3.
0+47	FAC: "The first target will be a tank platoon consisting of 4 tanks. The tanks are oriented in an east-west line in their revetments, which are spaced 30 meters apart. The target area is east of a railroad and 50 meters south of a tree line that extends from the railroad to the start of a heavily wooded area."
1+09	FAC: "The target area is at the 12 o'clock position."
1+12	Target 3-1 first visually available.
1+23	On top Target 3-1.
1+27	FAC: "The second target is an anti-tank battery. It consists of 2 guns in revetments and 2 trucks. It's located in an elongated clearing which is oriented southeast to northwest. The target is located near the midpoint of this clearing."
1+46	FAC: "The target is now at 12 o'clock."
1+48	Target 3-2 first visually available.

2+00 On top target 3-2.

2+08 FAC: "The next target is a FROG site of surface-to-surface missiles. It consists of one missile, 4 trucks, and one jeep. The target's located on the east side of a tree line of a north-south clearing. As you approach the target area, the small building will appear on your right, and another small clearing just prior to the target."

2+31 FAC: "The target is now at 12 o'clock."

2+32 Target 3-3 first visually available.

3+38 On top Target 3-3.

4+00 FAC: "The next target is a SAM site. We've got 6 SAM's on launchers plus 7 trucks and radar vans. The SAM complex is located in a 500 by 300 meter rectangular clearing in a heavily wooded area. The target complex is near the top of a ridge line. The missiles in the complex are distributed along the tree lines around the complex. The vans and other associated equipment are near the middle of this clearing."

4+48 FAC: "The target is at 12 o'clock."

4+50 Target 3-4 first visually available.

4+57 On top Target 3-4.

5+48 End of Mission 3.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 4

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0-02	FAC: "The targets for this mission are located in flat wooded terrain. Terrain elevation is 350 to 700 feet with trees to 40 feet."
0+00	First scene appears.
0+08	FAC: "The IP Point, which is at your one o'clock moving towards 12 at this time, is a prominent water tower which is part of an industrial complex."
0+14	IP-4 first visually available.
0+35	On top IP-4.
0+41	FAC: "The first target is a tank convoy located on the left side of an east-west hard surface road. The target is approximately 900 meters west of a small town and a road intersection. The convoy consists of 5 tanks which are spaced approximately 100 meters apart."
1+43	FAC: "The target is in your 12 o'clock position."
1+45	Target 4-1 first visually available.
1+55	On top Target 4-1.
1+59	FAC: "The next target is a vehicle park located on the south side of an east-west hard surface road. The target is 15 trucks in a 200 meter radius area. The trucks are parked at random. The truck park is 150 meters west of a road intersection."
2+13	Target 4-2 first visually available.
2+14	FAC: "The target is coming at your 12 o'clock now."
2+20	On top Target 4-2.

2+47 FAC: "The next target area is a SAM complex containing 4 SAM launchers with 2 SAMs per launcher. The SAM site is located south of an east-west road approximately 10 meters. There is a large clearing with a small finger which extends towards this road. The SAM site is located in this small finger. The SAMs are oriented north-south and are near the western tree line."

3+24 FAC: "The target is at your 12 o'clock position."

3+27 Target 4-3 first visually available.

3+41 On top Target 4-3.

4+31 FAC: "The next target is an anti-aircraft machine gun position. The target consists of 2 quad 50's that are revetted. The revetments are 25 meters apart and are located 35 meters north of an east-west road. The target area is in a large cleared area, and there are prominent earth scars which stand out against the green vegetation."

6+00 FAC: "The target is coming up in the 12:30 position."

6+03 Target 4-4 first visually available.

6+10 On top Target 4-4.

6+15 End of Mission 4.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 5

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0-03	FAC: "Targets for this mission are located in flat partially wooded terrain, elevation 300 to 500 feet, trees to 40 feet."
0+00	First scene appears.
0+04	FAC: "The IP is a road intersection of a hard surface road which bends northwest, then back west and a dirt road that intersects at that point.
(0+12)	"Our first target which is shortly after the Initial Point is a triple A 57 mm gun position with 6 revetments; 4 revetments are occupied.
(0+20)	"The IP is at 12 o'clock now."
(0+24)	"The guns are located 100 meters south of an east-west road. There is a small pond 200 meters prior to the target."
0+26	IP-5 first visually available.
0+30	On top IP-5.
0+36	FAC: "Target is at 12 o'clock."
0+38	Target 5-1 first visually available.
0+45	On top Target 5-1.
0+54	FAC: "The next target is a SAM convoy consisting of 3 SAM's on transporters. The transporters are located 10 meters north of an east-west road. The road makes a "C" curve just prior to the target."
1+02	Target 5-2 first visually available.
1+06	FAC: "Target is at 12 o'clock."

1+13 On top Target 5-2.

3+30 FAC: "The next target is a truck convoy consisting of 7 vehicles. The vehicles are located 10 meters off the north side of an east-west road. The vehicles are at 100 meter intervals."

3+48 FAC: "A large tin-roofed building 100 meters on the north side of the road and a pond 300 meters on the south side of the road are one click prior to the target."

4+17 FAC: "Target is at 12 o'clock."

4+18 Target 5-3 first visually available.

4+31 On top Target 5-3.

5+46 FAC: "Next target is a triple A machine gun battery. The battery consists of 3 quad 50's in revetments. The fourth revetment in the complex is unoccupied. The guns are 50 meters north and 50 meters east of a "T" intersection of 2 dirt roads. The east-west dirt road makes a "C" turn 2 clicks prior to the target."

6+17 FAC: "The target is partially obscured in cloud shadows."

6+39 FAC: "Target is at 12 o'clock."

6+41 Target 5-4 first visually available.

6+46 On top Target 5-4.

7+02 End of Mission 5.

COLLATION OF MISSION EVENTS AND FAC COMMENTARY

MISSION 6

TIME	EVENT
Prior to mission start	FAC: "Mustang Flight, this is your friendly FAC, Cobra 07."
0+00	First scene appears.
0+34	FAC: "The targets in this mission are located in flat partially wooded terrain. Terrain elevation runs 500 feet, with trees to 40 feet."
1+03	FAC: "The IP for this mission is a blue-roofed structure located 800 meters east of an intersection of a hard surfaced road and a dirt road, and it's located midpoint between the 2 roads. The building is also located among several other structures."
1+40	FAC: "The IP is partially hidden behind tall trees."
2+19	FAC: "The IP's at the 10 o'clock position now."
2+28	IP-6 first visually available.
2+35	FAC: "The IP is at 12 o'clock."
2+42	On top IP-6.
2+44	FAC: "IP now."
2+50	FAC: "First target is a SAM convoy. The target consists of three SA-2 SAM's on transporters. The targets are 10 meters south of an east-west road and midway between a road and a railroad. A dirt road 20 meters south of the targets bends off sharply to the southeast."
3+34	FAC: "A road intersection with a group of buildings in the north-west corner is approximately 800 meters prior to the target."
4+06	FAC: "Target is at 12 o'clock."
4+08	Target 6-1 first visually available.

4+16	On top Target 6-1.
4+26	FAC: "The second target is a light triple A battery. The battery consists of three 37 mm revetted guns, and the revetments are set in a triangular pattern. The guns are located 20 meters south of a parallel railroad track and hard surface road. A pond approximately the same size of the target complex is 5 meters west of the first gun. The target is also located in an open field just prior to a perpendicular road intersection."
5+21	FAC: "The target is at 12 o'clock."
5+23	Target 6-2 first visually available.
5+28	On top Target 6-2.
5+31	FAC: "The next target is a tank convoy, consisting of 4 tanks and a recovery vehicle, located 5 meters south of an east-west road and equal distance between the road and the railroad tracks. The tanks are spaced 100 meters apart."
5+42	Target 6-3 first visually available.
5+49	FAC: "Target is at 12 o'clock."
6+03	On top Target 6-3.
6+05	FAC: "The next target is a vehicle park consisting of 10 vehicles parked at random. The center of the target is 100 meters north of an east-west road and just prior to where the road bends to the left."
6+11	Target 6-4 first visually available.
6+14	FAC: "The target is at 11:30."
6+22	On top Target 6-4.
7+41	End of Mission 6.

TAB B

APPENDIX 1

ANNEX A

COMPLEXITY STUDY

GENERAL BRIEFING

Good (morning, afternoon), my name is ________________________, and this is ____________________.

We are here from the Boeing Aerospace Company for the study in which you are about to participate. First let me thank you for being here to spend some time with us to help us find answers to one of the many significant questions arising in the complex operational and research area of visual air-to-ground target acquisition.

I would like to give you a brief overview of the SEEKVAL program and its objectives, and then we will move on to particulars regarding today's tasks. The total time that we will require your services is about 2-1/2 hours, during which we will take several short breaks. Your participation should be complete before noon.

This test is only one small portion of a large-scale joint services effort titled "Operational Test and Evaluation of the Capability to Acquire Targets in Combat Air Support." A multi-year series of simulator and lab tests, later to be validated by field trials, will be used to develop a predictive capability for the design and operation of more cost effective air-to-ground systems.

Lt. Gen. Glenn A. Kent, the Director of the Weapon Systems Evaluation Group, states in a Department of Defense memorandum that "Acquisition of targets on the ground by observers in combat air support aircraft is a complex problem and involves a large number of factors relating to targets and their backgrounds, the atmosphere, and the characteristics of the acquisition systems themselves. All of these factors are known to affect target acquisition under one or more conditions."

Essential to this approach is the development of qualified test data for each of the factors affecting acquisition performance. You are participating in one of these studies.

The procedures we will use today may seem quite artificial to you and far removed from operational situations. We know that, but the data, and the way we collect it, provide a vital link between the output of analytical efforts and field test results. The combination of these will help us

predict, if not prevent, what difficulties you might have to expect when searching for targets under specifiable operational conditions in various parts of the world.

Because of the nature of these tests and particularly to keep the data as unbiased as possible, there are certain ground rules we would like you to adhere to:

GROUND RULES

RULE 1: Please do not discuss any part of the test among yourselves until we have collected all data, especially <u>not</u> during the breaks, and do not tell others who may be scheduled to participate what the task was about or what you did.

RULE 2: These tests are non-competitive. There are no right or wrong responses. In other words, we are interested in your individual opinion, and your response may very well differ from your neighbor's.

RULE 3: When asked to make a choice, make a choice even if it is difficult for you, and mark it on your answer sheet. Leave no items unanswered, blanks in the data list invalidate the whole procedure.

RULE 4: Should you at any time get lost on your answer sheet or lag behind, tell us at once and we will help you get caught up.

RULE 5: Please try to give us your responses to the best of your ability, and try to make your choice on the same basis throughout the session.

SPECIFIC INSTRUCTIONS TO SUBJECTS

Now, let me turn to the specifics of this study. As you might have noticed in some of your flight experiences, the difficulty in finding and identifying given man-made ground targets is, among other factors, dependent upon the type of terrain, foliation, number, size, and distribution of other target-like objects, color and color contrasts, and so on. This combination may be called "scene complexity". Since all observers do not make a uniform interpretation of these factors, it has been decided to use a new technique to evaluate this "scene complexity".

You will be shown a series of slide pairs depicting air-to-ground views taken at about 300 feet above the ground. Imagine you were flying a low-level target-search or reconnaissance mission at a speed of 360 knots, during which you encounter each of the scenes shown in the slide pairs. Imagine further that your mission task was to search for and identify small tactical targets such as tanks, trucks, triple-A, missiles, radar vans, and mortars, either individually or in operational units. There may be targets of some kind visible in some of the scenes. There are no targets in heavily concealed locations, such as forested areas that are not normally visible from the air.

Now, based upon this assumed situation, decide in which of the two scenes you think it would be easier to find and identify small tactical targets, disregarding areas of heavy concealment and disregarding whether or not targets are actually present. Indicate your choice on your response sheet in the following manner: for each slide pair, circle the letter L or R, that is, left or right, to designate the scene in which, in your opinion, it would be easier to find and identify small tactical targets. Base your judgement on the total scene and not only on specific items within the scene. I would like to point out that in some scenes you may actually see tactical targets, but your judgement of the entire scene should not be based on these items alone.

In addition, you may notice that a few scenes differ significantly in color and area coverage from the rest of the scenes. These are terrain table scenes and are not real-world like most of the slides. These scenes are part of another study in the same large-scale effort mentioned previously. Try to ignore this type of variation and pick the scene which, in real flight, would present a lesser problem in finding and identifying targets.

You may find it difficult to make a choice between some slide pairs. Test procedures, however, do require that you select one slide of each slide pair as the less difficult, even when they are quite similar, and mark it on your answer sheet as being a scene in which you think it would be easier to find and identify tactical targets.

We will not be able to answer any questions during the experimental run because there is a 10 second viewing time limit for each slide pair, so we will now have a short familiarization session during which we will try to answer any procedural questions regarding the task: Again, there are no right or wrong answers; we want your best judgment as to the scene in which it would be easier to find and identify tactical targets.

TAB C

APPENDIX 1

ANNEX A

AMBIGUITY STUDY

GROUND RULES

RULE 1: Please do not discuss any part of the test among yourselves until we have collected all data, especially not during the breaks, and do not tell others who may be scheduled to participate what the task was about or what you did.

RULE 2: These tests are non-competitive. There are no right or wrong responses; in other words, we are interested in your individual opinion, and your response may very well differ from your neighbor's.

RULE 3: When asked to make a response, make a response even if it is difficult for you, and mark it on your answer sheet. Leave no items unanswered; blanks in the data list invalidate the whole procedure.

RULE 4: Should you at any time get lost on your answer sheet or lag behind, tell us at once and we will help you get caught up.

RULE 5: Please try to give us your responses to the best of your ability, and try to make your responses on the same basis throughout the session.

AMBIGUITY STUDY

SPECIFIC INSTRUCTIONS TO SUBJECTS

Now, let me turn to the specifics of this study. As you have probably noticed in some of your flight experiences, the difficulty with which one can find and identify assigned targets is, among other factors, dependent upon the number and distribution of ground items that catch one's attention as being possible target elements.

Since the time spent viewing such items affects the probability and range that the real target of interest can be found, it is important to learn the number of such items that may occupy the observer's time during a target encounter.

Imagine you had to fly a low-level target search or reconnaissance mission at about 300 feet above the ground and at 300 knots. We will show you a number of slides depicting air-to-ground views taken during such a mission. View each scene presented and count the number of cues or things that catch your attention enough to cause you to pause in your general scanning and inspect them closer for being potential target elements or sites. Enter this total number for each scene on your answer sheet. Try to keep track of each location or area that attracts your attention, even if only momentarily. Whether or not a target is found is unimportant.

Assume, for the purpose of your imaginary mission today, that you are searching for targets like triple A's, military convoys, vehicle parks, and missile sites. You may or may not see such targets in the scenes, but what we want you to do is to count the number of locations or areas in the scene that at first impression might contain a tactical target or target site.

In addition, you may notice that a few scenes differ significantly in color and area coverage from the rest of the scenes. These are terrain table scenes and are not real-world, like most of the slides. These scenes are part of another study in the same large-scale effort mentioned previously.

We will not be able to answer any questions during the actual study because the total viewing time for each slide is only 12 seconds. We will have a short familiarization session next during which we will try to answer any procedural questions you might have.

AMBIGUITY STUDY FAMILIARIZATION

For the first familiarization scene, let me "walk" you through the required task as I would count some of the areas or locations in the scene that might contain a small tactical target, or target site.

The first area that catches my eye is the road in the bottom-center of the scene. I feel that this road, with its line of trees, deserves closer inspection.

The second area that "catches my attention" is the group of trees here and what may be their shadows or possible vehicles of some sort.

A third location that I pause to inspect is along the edge of these trees. Here, the ground tone differences make me look closer to inspect for a tactical target.

Other areas or locations that catch my attention are these areas here, here, and here, that appear to contain man-made objects or buildings.

Now, with this scene, and the next four practice scenes, you count the number of areas or locations that cause you to pause in your scanning and inspect closer. Remember, what I see, or the person next to you sees, will not necessarily be the same things, or number of things.

Mark your responses on the practice answer sheet.

Each scene will be shown for 12 seconds.

TAB D

APPENDIX 1

ANNEX A

STATIC DETECTION STUDY

INSTRUCTIONS

Live:

Good (morning, afternoon) gentlemen, I am ________________________, and this is ____________________________.

We will be spending the (morning, afternoon) with you for this Target Detection Study. This study should be complete in about 2-1/2 hours.

In order to maintain standard conditions, the rest of this introductory material and most of your briefing will be taped or written.

From Tape Recorder:

We would first like to give you a brief overview of the SEEKVAL program and its objectives. Then we will move on to your specific instructions.

This experiment is one portion of a large-scale effort entitled "Operational Test and Evaluation of the Capability to Acquire Targets in Combat Air Support". A multi-year series of simulator and laboratory tests, later to be validated by field trials, will be used to develop a predictive capability for the design and operation of more efficient air-to-ground systems.

Lt. Gen. Glenn A. Kent states in a Department of Defense memorandum that "Acquisition of targets on the ground by observers in combat support aircraft is a complex problem. It involves a large number of factors relating to targets and their backgrounds, the atmosphere, and the characteristics of the acquisition systems themselves. All of these factors are known to affect target acquisition under one or more conditions.

"Consequently, a program to evaluate the effectiveness of devices for enhancing acquisition in an operational environment based solely on field testing would require extensive resources.

"Also, there are problems in instrumenting a field test and obtaining meaningful results in such a test. Accordingly, a program based on simulations, validated by limited field tests, appears to be the best avenue of approach. . ."

Essential to this approach is the development of qualified test data for each of the factors affecting acquisition performance. You have been selected to participate in one of these studies.

The procedures we will use today may seem quite artificial to you and far removed from operational situations. We know that, but the data and the way we collect it provide a vital link between the output of analytical efforts and field test results.

Today you will be shown 26 individual target encounters. In each of these target encounters we will be interested in three principal measures of your performance:

First, whether or not you acquired the target.

Second, the time and range at which you acquired the target.

Third, whether or not you "acquired" false targets.

In our data analysis, these three measures will be combined into a single score, so in your search for each target, try to give equal importance to acquiring the correct target and to acquiring it as soon as possible.

Now, let's turn to the specifics of this study. It has been shown in previous studies that length of time available for search is an important variable in target acquisition. In this study we are presenting each scene in the target encounter for an equal length of time in an attempt to control this variable. We are not presenting continuous scenes, but individual static scenes from target encounters at decreasing ranges. You will be shown the series of 26 encounters depicting consecutive air-to-ground views taken at about 300 feet above ground level. Imagine you had to fly a low-level target search or reconnaissance missions along the ground tracks shown in the slide sequences.

You will view the sequence of slides starting within search range from each target and advancing toward the target. Your task will be to search each scene for the assigned target. The timing sequence is automatically controlled. When you believe you have detected the target with enough confidence that you would be willing to commence attack-related actions such as turning the aircraft to fulfill weapon delivery requirements or attempting to lock a weapon seeker on the target, push the timer control button to freeze the slide display and immediately point the light arrow at the target. You will not be told if your response is correct. On each succeeding scene repeat this sequence. While operationally, you might sometimes commit to deliver ordnance before you actually see the target, here we would like you to wait until you see some element of the target itself. How much of the target you must see to reach an acquisition decision is largely up to you. You should be reasonably certain that the target you see is the target you are looking for.

If you realize you have made a false detection, push the timer control button again and point to the correct target. There may be times when you are actually pointing to an object in the target area other than the target. If you realize you have made a false detection, push the timer control button again, designate the correct target and tell us on what in the scene you based your earlier designation.

The 26 targets are divided into 6 missions, with either 4 or 5 separate target encounters on each mission. Each mission will be preceded by a short study session. You will be shown, for each target, 2 black and white briefing photographs, one vertical and one oblique, and you will be given the general characteristics of the targets for which you will be looking.

In two of the encounters, you may notice that the scenes differ significantly in color and area coverage from the rest of the scenes. These are terrain table scenes and not real-world like the rest of the imagery. This is a terrain table scene, . . . and this is a real-world scene. Your target detection procedures, however, are the same for both.

Before you begin your 26 target encounters, we will show you two practice target encounters to familiarize you with the procedures. We will go through these in the same manner as your 26 encounters to provide you a chance to practice and ask any questions you might have.

Before you are given the detailed briefings for your 2 practice target encounters, called Mission Zero, here are some ground rules we would like you to follow:

GROUND RULE 1 - In each of your 6 missions you will be required to search for 4 or 5 targets. Targets will be encountered one at a time. Your task will be to acquire the target and designate it as soon as possible. Target acquisition responses will always be made by first pressing the timer control button and then immediately pointing the light arrow at the target.

GROUND RULE 2 - Each of your target encounters begins within search range of your target - begin searching with the first slide in each sequence.

GROUND RULE 3 - The target name will be called out at the start of each encounter.

GROUND RULE 4 - Please do not discuss the targets or the procedures with others who may be participating in this study.

APPENDIX 2

ANNEX A

SUBJECT CHARACTERISTICS

1. INTRODUCTION

There were a total of 292 subjects in the four studies. The Complexity Study had 100 subjects, the Ambiguity Study had 100, and the Dynamic Imagery Experiment had 72 subjects. In these studies, one-fourth of the subjects were taken from each of the services, Air Force, Army, Marine Corps, and Navy. The 20 subjects in the Static Detection Study were all from the Marine Corps. All subjects were required to have been operationally current aircrew members within the last 18 months.

Sometime during their participation in the studies, the subjects were asked to complete an Observer Questionnaire which included questions on biographical data, physiological condition and operational experience. A sample questionnaire is shown in Figure 2-A-1.

2. BIOGRAPHICAL DATA

The distribution of subject age, rank, level of education, years in military service, and years as rated flight crew members are shown in Tables 2-A-1 through 2-A-5.

3. PHYSIOLOGICAL CONDITION

Data on the physiological condition of the subjects is summarized in Tables 2-A-6 through 2-A-14.

4. OPERATIONAL EXPERIENCE

A summary of operational flight experience, military flight training and combat flight experience was given by each subject.

The most frequently listed military combat flight schools are shown in Table 2-A-15. Two hundred twenty six of the 292 subjects had some combat flight experience, all in Southeast Asia. The numbers of hours are shown in Table 2-A-16. The range in number of combat flight hours was 0 to 2900 hours. The number of subjects' operational hours as pilot, navigator and other crew, and in low-level flight (below 1,000 feet) are shown in Tables 2-A-17 and 2-A-18. The range in number of operational hours was 0 to 6400 hours, and the range in number of hours of low level flight was 0 to 3600 hours. The types of aircraft flown by the subjects are summarized in Table 2-A-19.

SEEKVAL TEST 1A2

OBSERVER QUESTIONNAIRE

NAME ______________________ STUDY ______________________

RANK ______________________ DATE ______________________

BRANCH ______________________ SUBJECT ______________________

Please circle the number for the proper response or fill the blank.

GENERAL QUESTIONS

1. What is your age?

    1. Under 26
    2. 26 - 35
    3. 36 - 45
    4. Over 45

2. How long have you been in the service?

    1. 0 - 5 years
    2. 6 - 10 years
    3. 11 - 15 years
    4. Over 15 years

3. How long have you been a rated flight crew member?

    1. 0 - 5 years
    2. 6 - 10 years
    3. 11 - 15 years
    4. Over 15 years

4. What is your level of education?

    1. No college
    2. Some college
    3. College graduate
    4. Advanced degree

FIGURE 2-A-1

QUESTIONS ON PHYSIOLOGICAL CONDITION

5. How many cigarettes do you normally smoke per day?

   1. None
   2. Less than one pack
   3. One to two packs
   4. More than two packs

6. How many cigarettes have you smoked in the last 24 hours?

   1. None
   2. Less than one pack
   3. One to two packs
   4. More than two packs

7. How much sleep do you normally get at night? ______ hours

8. How much sleep did you get last night? ______ hours

9. Have you taken any medication in the last 48 hours?

   1. Yes
   2. No

   If yes, what medicine and dosage?

10. - 15. Do you presently have:

10.	a cold?	1. Yes	2. No
11.	a headache?	1. Yes	2. No
12.	sinus trouble?	1. Yes	2. No
13.	a toothache?	1. Yes	2. No
14.	an upset stomach?	1. Yes	2. No
15.	arthritis?	1. Yes	2. No

16. Were your eyes fatigued or irritated before this study began?

   1. Yes
   2. No

17. How many cups of coffee or tea have you consumed in the last 24 hours? ______

18. How many alcoholic drinks have you had in the last 24 hours?

   Beer ______ Other ______

Figure 2-A-1

QUESTIONS ON OPERATIONAL EXPERIENCE

19. Please list the aircraft in which you are operationally current in the last two years.

20. Beyond initial flight training, what military schools have you attended for flying combat readiness?

1.

2.

3.

4.

21. What has been your combat flight experience?

1. Southeast Asia ________ missions ________ hours

2. Korea ________ missions ________ hours

3. World War II ________ missions ________ hours

22. Please estimate the number of operational hours you have spent doing the following kinds of flying:

Aircraft Class	Type	Pilot	Navigator	Other Crew	Low Level - Below 1000 Feet
Fighter					
Attack					
Helicopter					
Recce					
Bomber					
Other (What?)					

Figure 2-A-1

23. Other than flying, what operational experience have you had relevant to target acquisition?
Examples are: Operation planning dealing with military targets or combat mission planning.

24. Have you had any prior experience with target acquisition simulation?

25. Other than your assignment as a participant in this test, have you had any exposure to the SEEKVAL program?

1. Yes
2. No

If "Yes", please specify

Figure 2-A-1

5. EXPERIENCE WITH TARGET ACQUISITION

Slightly over half of the 292 subjects reported having some operational experience relevant to target acquisition. Types of experience are shown in Table 2-A-20. Forty-eight of the subjects had prior experience with target acquisition simulation. Table 2-A-21 lists the types of experience given. None of the subjects had previous exposure to the SEEKVAL program.

6. VISION TESTS

Each subject in the Dynamic Imagery Experiment was tested for visual acuity and color vision. Seventy of the 72 subjects had a binocular visual acuity score of 20/30 or better, one scored 20/40 and one scored 20/50. Sixty-nine of the subjects had normal color vision and three had weak red-green discrimination. Subjects who wore glasses in the simulator were asked to wear them for the tests.

TABLE 2-A-1 AGE

STUDY	Under 26	26-35	36-45	Over 45
Complexity	25	66	9	0
Ambiguity	18	75	7	0
Static Detection	4	16	0	0
Dynamic	10	45	17	0

TABLE 2-A-2 EDUCATION

STUDY	No College	Some College	College Graduate	Advanced Degree
Complexity	0	30	60	10
Ambiguity	5	17	67	11
Static Detection	0	4	16	0
Dynamic	4	14	47	7

TABLE 2-A-3 RANK

STUDY	WO-1	CWO	2nd Lt/ Ensign	1st Lt/ LTJG	Capt/ LT	Maj/ LCDR	Lt Col/ CDR	Col/ Capt.	Flt. Lt. (RAF)
Complexity	1	15	0	20	52	12	0	0	--
Ambiguity	1	15	2	20	53	9	0	0	--
Static Detection	0	1	0	11	8	0	0	0	--
Dynamic	1	11	0	11	26	14	7	1	1

TABLE 2-A-4 YEARS IN SERVICE

STUDY	0-5 Years	6-10 Years	11-15 Years	Over 15 Yrs.
Complexity	34	42	15	9
Ambiguity	43	37	10	10
Static Detection	12	6	2	0
Dynamic	23	25	10	14

TABLE 2-A-5 YEARS AS RATED FLIGHT CREW MEMBER

STUDY	0-5 Years	6-10 Years	11-15 Years	Over 15 Yrs.
Complexity	55	35	8	2
Ambiguity	63	32	4	1
Static Detection	17	3	0	0
Dynamic	34	21	9	8

TABLE 2-A-6 CIGARETTES NORMALLY SMOKED PER DAY

STUDY	None	Less Than One Pack	One to Two Packs	More Than Two Packs
Complexity	62	16	22	0
Ambiguity	71	14	15	0
Static Detection	14	5	1	0
Dynamic	41	15	16	0

TABLE 2-A-7 CIGARETTES SMOKED IN LAST 24 HOURS

STUDY	None	Less Than One Pack	One to Two Packs	More Than Two Packs
Complexity	63	24	13	0
Ambiguity	71	21	7	1
Static Detection	14	5	0	1
Dynamic	41	17	14	0

TABLE 2-A-8 NORMAL AMOUNT OF SLEEP

STUDY	6 Hours Or Less	7 Hours	8 Hours	9 Hours	10 Hours Or More
Complexity	6	35	52	7	0
Ambiguity	15	48	30	6	1
Static Detection	2	10	8	0	0
Dynamic	11	33	26	2	0

TABLE 2-A-9 AMOUNT OF SLEEP LAST NIGHT

STUDY	3 Hr.	4 Hr.	5 Hr.	6 Hr.	7 Hr.	8 Hr.	9 Hr.	10 Hr. or More
Complexity	1	0	2	24	30	31	9	3
Ambiguity	1	2	8	19	28	26	11	5
Static Detection	0	1	2	4	8	3	1	1
Dynamic	0	1	2	17	18	17	9	8

TABLE 2-A-10 MEDICATION TAKEN IN LAST 48 HOURS

STUDY	Yes	No
Complexity	5	95
Ambiguity	10	90
Static Detection	0	20
Dynamic	4	68

TABLE 2-A-11 EYE FATIGUE

STUDY	Yes	No
Complexity	6	94
Ambiguity	11	89
Static Detection	4	16
Dynamic	3	69

TABLE 2-A-12 PRESENT STATE OF HEALTH

STUDY	COLD	HEADACHE	SINUS TROUBLE	TOOTH-ACHE	UPSET STOMACH	ARTHRITIS
Complexity	18	5	3	0	0	0
Ambiguity	15	8	2	1	2	1
Static Detection	1	1	0	0	0	0
Dynamic	9	4	2	0	1	1

TABLE 2-A-13 CUPS OF COFFEE OR TEA IN LAST 24 HOURS

STUDY	0	1	2	3	4	5	6	7	8	9	10	More than 10
Complexity	17	14	13	13	15	6	5	4	3	0	7	3
Ambiguity	23	10	9	12	16	15	4	0	4	0	5	2
Static Detection	5	3	0	1	4	1	1	2	0	0	0	3
Dynamic	7	6	11	7	19	7	8	2	2	2	1	0

TABLE 2-A-14 ALCOHOLIC DRINKS IN LAST 24 HOURS

	BEER									OTHER								
STUDY	0	1	2	3	4	5	6	7	8 or More	0	1	2	3	4	5	6	7	8 or More
Complexity	71	9	7	6	3	0	3	0	0	81	7	4	2	2	1	1	1	1
Ambiguity	73	11	6	2	3	2	3	0	0	76	4	7	8	1	2	2	0	0
Static Detection	16	3	1	0	0	0	0	0	0	15	3	1	0	1	0	0	0	0
Dynamic	43	7	9	3	3	0	3	1	3	40	5	7	5	2	4	5	2	3

TABLE 2-A-15 MILITARY COMBAT FLIGHT READINESS SCHOOLS

STUDY	A/C Upgrade	Basic Conven. Weap. Deliv.	Tact. Conven. Weap. Delivery	Nuc. Weap. Delivery	Air Combat Tactics	Nap of the Earth	Forward Air Controller	Survival	Other	None
Complexity	70	11	6	3	20	4	3	16	15	14
Ambiguity	54	4	5	5	1	4	3	10	20	31
Static Detection	1	3	6	5	2	0	1	0	5	7
Dynamic	52	15	9	4	5	0	1	4	35	19

TABLE 2-A-16 COMBAT FLIGHT HOURS

STUDY	0 Hours	1 to 100	101 to 500	501 to 1000	Over 1000
Complexity	17	6	35	22	15
Ambiguity	20	11	38	18	14
Static Detection	13	1	3	2	1
Dynamic	16	5	28	12	11

TABLE 2-A-17 OPERATIONAL FLIGHT HOURS

STUDY	Duty	0 Hours	1-100	101-500	501-1000	1001-2000	2001-3000	Over 3000
	Pilot	2	2	9	19	27	14	5
Complexity	Nav.	-	0	5	9	6	1	1
	Other	-	3	8	1	2	0	0
	Pilot	-	0	11	17	24	11	7
Ambiguity	Nav.	-	5	4	9	6	1	1
	Other	-	3	6	3	0	0	0
	Pilot	-	1	5	3	2	1	1
Static Detection	Nav.	-	0	4	1	1	0	0
	Other	-	0	0	0	1	0	0
	Pilot	-	0	6	16	18	11	6
Dynamic	Nav.	-	1	3	1	2	2	2
	Other	-	0	3	3	1	3	0

TABLE 2-A-18 LOW LEVEL FLIGHT HOURS

STUDY	0 Hours	1 to 100	101 to 500	501 to 1000	1001 to 2000	Over 2000
Complexity	6	35	30	19	7	3
Ambiguity	4	38	28	20	8	2
Static Detection	0	11	5	2	2	0
Dynamic	2	15	26	18	9	2

TABLE 2-A-19 AIRCRAFT TYPE

STUDY	Fixed Wing Only	Helicopter Only	Fixed Wing and Helicopter
Complexity	64	23	13
Ambiguity	67	21	12
Static Detection	12	5	3
Dynamic	44	16	12

TABLE 2-A-20 OPERATIONAL EXPERIENCE RELEVANT TO TARGET ACQUISITION

STUDY	Mission/Operations Planning	Intell/Brief-Debrief/ Tgt Study	FAC/Observer	Close Air Support	Photo Interpretation	Armor/Infantry/ Gunnery Acq/Recon	Radar Tgt Intell/ Radar Prediction	Tact. Air Liaison	Tank Tactics	Mine Field Planning	Aircraft Recognition	Combat Zone	Special Forces	Laser Target Desig.	NOE Instructor	None
Complexity	40	8	8	4	2	3	0	2	2	0	0	0	0	0	0	54
Ambiguity	24	2	6	0	4	5	3	0	1	1	1	1	1	0	0	52
Static Detection	4	6	0	0	0	0	3	0	0	0	0	0	0	0	0	2
Dynamic	31	8	2	3	2	2	3	0	1	1	0	0	0	1	1	27

TABLE 2-A-21 PRIOR EXPERIENCE WITH TARGET ACQUISITION SIMULATION

STUDY	Yes	No	TYPES OF PRIOR EXPERIENCE
Complexity	15	85	Radar Prediction Viewing Maps/Slides Electronic Tracking (TV) Low Level Boeing Simulator
Ambiguity	19	81	JTF-2 Study TACP Photographic Field Artillery School Photo Reconnaissance
Static Detection	3	17	Ground Targets Flight School Radar Flight Simulator Nap of the Earth
Dynamic	11	61	Weapon System Trainer Bullpup Training Air Tactics Movies Training Films

APPENDIX 3

ANNEX A

TAB A

DEBRIEFINGS FROM DYNAMIC IMAGERY EXPERIMENT

1. INTRODUCTION

Each subject in the Dynamic Imagery Experiment was given a series of debriefing questionnaires: A Flight Debriefing after each of the six test flights, and a Final Debriefing at the end of his participation in the study. These are shown in Figure 3-A-1 and 3-A-2. In the questionnaires the subjects were asked about their general impressions of the simulator and test, their methods of briefing and searching for targets and their use of briefing materials and inflight aids.

2. IMPRESSIONS OF THE SIMULATOR AND TEST

The majority of the subjects seemed quite favorably impressed with the simulation facilities and the conduct of the test. Most were able to appreciate the purposes of the test and considered their participation to be worthwhile.

A very high percentage of the subjects thought that the simulated flights were quite realistic. The most frequently mentioned factor detracting from the realism was their lack of aircraft control responsibilities - they were able to devote an unrealistically large proportion of their time to searching for targets. Most of the subjects, however, were able to understand and appreciate the reasons for limiting their task loads. Other comments included the unconventional mission scenarios and unrealistic placements of targets. Some of the subjects were bothered by the discrepancy between visual and vestibular motion cues - their eyes told them they were in a moving aircraft, but the simulator cockpit was motionless.

A major difference found between the simulator and the real world was related to the film resolution. Because the picture was always somewhat blurred, the subjects complained that they could not see as far ahead in the simulator as they normally could. Very often they reported being able to identify the target area quite easily, but the target itself was identified only at very close range or was missed entirely.

Only a few of the subjects noticed that the film was being shown backwards. None of the subjects reported that this condition detracted from their ability to acquire targets.

SEEKVAL 1A2

FLIGHT DEBRIEFING

Obs#	Flight	Condition	Mission
____	_____	_________	_______

1) The following materials were provided for mission planning. Please, rank order these items by usefulness for acquiring targets in the flight just completed, using the number 1 to indicate "most useful".

	IP	Tgt 1	Tgt 2	Tgt 3	Tgt 4
a) verbal description	____	____	____	____	____
b) 1:250,000 topo map	____	____	____	____	____
c) 1:50,000 picto map	____	____	____	____	____
d) target photos	____	____	____	____	____
e) TET	____	____	____	____	____

2) Which of the following did you use for keeping track of flight progress?

   a) elapsed time ______

   b) road patterns ______

   c) built-up areas ______

   d) bodies of water ______

   e) ridges and other terrain features ______

   f) none used ______

   g) other (specify) ______

3) Which of the things, if any, listed in Question 2 were most useful in finding the targets (give corresponding letters).

   IP ______

   Tgt 1 ______

   Tgt 2 ______

   Tgt 3 ______

   Tgt 4 ______

Comments (Flight specific)

FIGURE 3-A-1

<u>FINAL DEBRIEFING</u>   Observer No. ____ Name ____________________

1. As the number of flights completed increased, did you spend <u>more</u>, <u>less</u>, or the <u>same</u> amount of time in pre-flight planning? (circle one)

2) Please, rank order the usefulness of in-flight information made available to you during this experiment.

   a) TET ______
   b) Cartography
      1:250,000 topo ______
      1:50,000 picto ______
   c) FAC ______
   d) Range-to-go ______

3) Do you think the ease with which you found targets changed significantly as you completed more flights: YES NO (circle one)

   a) If yes, was this change <u>positive</u> or <u>negative</u>?
   b) Was the change due to different
      1) flight planning ______
      2) change in criterion for when to designate acquisition ______
      3) other (specify) ______

4) Do you think it was <u>easier</u>, <u>harder</u>, about the <u>same</u> to find targets at 220 Kts than at 360 Kts? (circle one)

5) Keeping in mind that controlled experiments and simulators have certain inherent simplifying assumptions, what were your impressions of the simulated flight and the manner in which the test was conducted?

6) Has your experience in this simulation study provided any new insight into the problems of low-altitude high-speed flight? If so, how might you implement such insight into the operational squadron?

7) Considering only the target acquisition portion of your task, did you perform it in a different way here than you would in the field?

8) Additional comments.

Figure 3-A-2

The aircraft speeds used in the simulator proved to be somewhat of a problem for a few of the subjects. Many of the helicopter pilots felt rushed in searching for targets even at 220 knots, while some of the jet pilots felt that 360 knots was uncomfortably slow and unrealistic for a threat environment. Some recommended that pilots be tested only at speeds closer to their own operational speeds.

A frequently made comment was the potential use of the simulator as a training aid. Many of the subjects considered the simulator to be realistic enough to give new pilots a good orientation in low altitude navigation.

When asked if their experience in the study had given them any new insights into the problems of low altitude, high speed flight which could be implemented in their own squadrons, a number of the subjects said they thought that they needed more practice in this type of mission, both in the field and in simulators. They also thought that the importance of preflight planning needed more emphasis in their training.

3. METHODS OF BRIEFING AND SEARCHING FOR TARGETS

The subjects were asked if they performed the target acquisition portion of their task differently in the simulator than they would in the field. About twice as many said they did not perform the task differently as said that they did perform it differently.

Of the subjects who said they performed the task differently, there were two primary reasons given. Due to poor film resolution, some subjects relied more on identifying features of the target area before identifying the target itself. Secondly, many said that they would ordinarily designate the target when they saw the target area rather than waiting to identify the target itself.

Other differences in performance mentioned by the subjects related to portions of the task other than target acquisition. In their flight planning, some said they relied more on total elapsed time and less on navigational checkpoints, since time was such a reliable cue in the simulator. Many said that they would approach the targets from the side rather than flying directly over them. Some said they would fly at higher or lower speed, higher or lower altitude, or would vary their flight path, speed and altitude more.

When asked about the amount of time spent in preflight planning, forty of the 72 subjects said that they spent less time planning as they completed more flights. This was attributed mainly to their becoming more familiar with the types of information that would be most useful to them. Twenty-six subjects spent the same amount of

time planning throughout the study and four increased their planning time as they completed more flights.

Fifty-four of the subjects said that it became easier to find targets as they completed more flights. Contributing factors included familiarization with the simulator, better use of briefing materials, familiarization with the types of target sites, and change in criterion for designating acquisition. Seventeen subjects reported no change in the ease of finding targets and none thought finding targets became more difficult as more flights were completed.

About two-thirds of the subjects said their performance was affected by mission airspeed. Forty-five found that it was easier to search for targets at 220 knots than at 360 knots, and 3 subjects said that it was harder at 220 knots. The remaining 24 found no difference in their performance at the two speeds, usually because the added search time at 220 knots was negated by trying to assimilate too much information during that time.

4. USE OF BRIEFING MATERIALS AND INFLIGHT AIDS

a. Introduction

The briefing materials provided to the subjects always seemed to be adequate for them to plan the flights to their satisfaction. Some commented that the materials provided were more complete than what they were used to using. In general, the subjects seemed to make use of most or all of the material available, rather than limiting themselves to one or two items.

b. Use of Individual Briefing and Inflight Aids

(1) Introduction. During the period prior to each flight, the subjects were given a verbal description of the mission, 1:250,000 scale and 1:50,000 scale map coverage of the course, and a flight plan with the total elapsed time and distance to each target. In the high briefing level (Conditions 5 and 6) they were also given target photos. In the simulator cockpit they had an elapsed time clock, a range-to-go indicator (Condition 1 only) and a forward air controller (Condition 2 only), as well as the map folder used in preflight planning.

In the Flight Debriefing given after each test flight, the subjects were asked to rate each of the briefing and inflight aids on their usefulness for each target. By combining responses across all targets, it is possible to see which of the aids were most useful in each of the 6 conditions, and to compare the usefulness of each aid among the 6 conditions.

The following paragraphs describe the subjects' evaluation of each of the available briefing and inflight aids.

(2) Verbal Description. The verbal description seemed to be necessary for most of the subjects, but it was rarely the most used of the briefing materials. The descriptions given seemed to be satisfactory, and there were few comments about them.

(3) Maps. There was quite a difference of opinion over the relative usefulness of the 1:250,000 scale and 1:50,000 scale maps. Some subjects found the 1:50,000 scale maps very useful, mostly for identifying clearings and other terrain features in the immediate target area, while others thought they were useless because they were traveling too fast to be able to see the amount of detail shown on the map. The majority of subjects used the 1:250,000 maps relatively little, using them only for an overview of the course, but a few relied on them heavily and excluded the 1:50,000 maps. Some subjects recommended the use of an intermediate scale map, such as 1:100,000 rather than the two scales given.

A common complaint related to the construction of the map folders. Some subjects thought the maps should have been put together in such a way that they could be used as a continuous track, rather than being broken into separate pages. Most, however, seemed satisfied with the booklet form used.

The type of map information used most by the subjects was road patterns. The next most used were ridges and other terrain features, especially shapes and patterns of clearings and groups of trees. Used to a lesser extent were towns and other built-up areas and bodies of water.

(4) Photos. Photos were by far the most useful of all the aids given to the subjects. In the two conditions with photos as part of the briefing information, photos were rated as the most useful item by the majority of subjects. Some subjects preferred the oblique photos, an equal number found the vertical photos most useful, while the majority of subjects used both type of photos.

(5) Elapsed Time. Since airspeed was held constant in the simulator, total elapsed time was a highly reliable aid in finding targets. In the conditions without photos or FAC, elapsed time was most often rated as the most useful aid. Elapsed time was most often rated as the second most useful item next to the photos or FAC when these aids were available. Some subjects commented that they relied more heavily on elapsed time in the simulator than they would in the field because it was so reliable in the tests.

(6) Range-to-Go Indicator. The range-to-go indicator appeared to be the least useful of all the aids provided - over one-third of the subjects said they ignored it altogether. It was most frequently rated as the least useful item, and least often rated as the most useful item. The subjects' lack of familiarity with this type of indicator is the most likely reason for its failure as an aid in target acquisition; most of them were accustomed to thinking in terms of time-to-go rather than distance-to-go. Several other units of measurement were suggested to replace feet-to-go: nautical miles, kilometers and yards were thought to be more easily related to the visual scene than feet. A few subjects did think the range-to-go indicator provided useful information.

(7) Forward Air Controller. Immediately after the flight with the FAC, the subjects most often rated the FAC as the most useful item. However, in rating the overall usefulness of the various aids at the end of their participation in the test, the subjects reported the FAC to be among the least useful of the aids.

The majority of the subjects considered the FAC descriptions to be helpful, both in early search for the target area and in positive identification of the target itself.

Many subjects thought that the FAC was unrealistic for the type of mission used in the test. Others reported that the FAC distracted them from studying the map and searching the visual scene for checkpoints and targets.

(8) Other Comments. Several subjects mentioned the desirability of adding a heading indicator to the simulator cockpit. Even though they had no control over the direction of flight, they thought a heading indicator would be helpful in maintaining orientation with the maps.

c. <u>Comparative Usefulness of Briefing and Inflight Aids</u>

In the flight debriefing questionnaires completed after each test flight, the subjects were asked to rank the available briefing and inflight aids by their usefulness on each target. Figure 3-A-3 shows the frequency with which each of the aids was ranked among the most useful items for each condition. The total score given for each item is the sum of the number of times it was ranked as the first most useful item, plus the number of times it was ranked as the second most useful item. The ordinate shows the percentage of targets on which each aid received a ranking of first or second most useful.

The graphs in Figure 3-A-3 show that in Conditions 1, 3 and 4, elapsed time was the most useful item. In Condition 2, the FAC and elapsed time were found to be most useful with almost equal frequency. The photos, given in Conditions 5 and 6, were most frequently found to be the most useful, with elapsed time being second most useful.

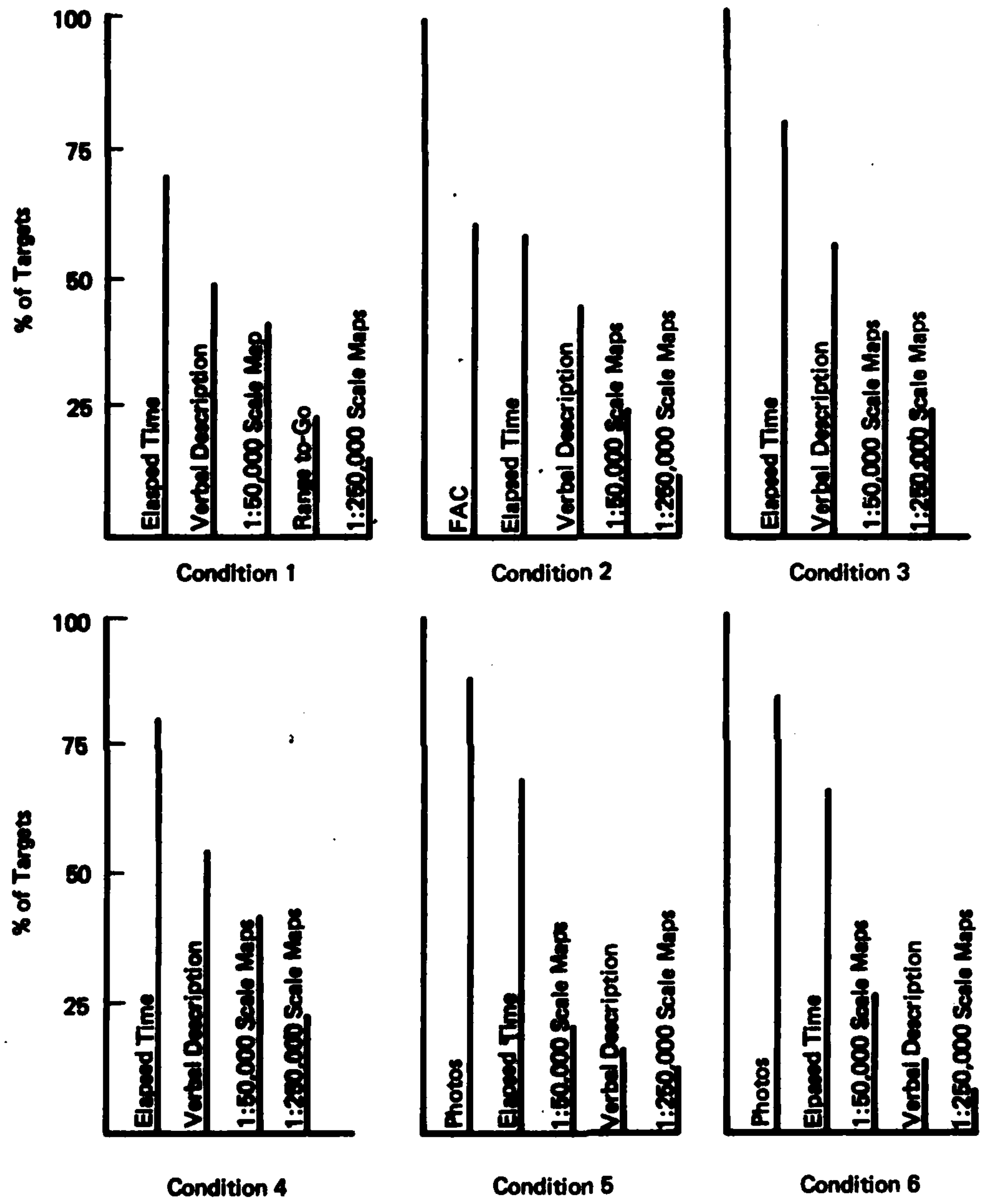

Figure 3-A-3: Most Useful Briefing and In-Flight Aids Dynamic Study

The verbal description was usually found to be somewhat more useful than the 1:50,000 scale maps, although when photos were available, the 1:50,000 scale maps were used more than the verbal descriptions. The 1:250,000 scale maps were least often ranked among the most useful items. In Condition 1, the range-to-go indicator was ranked as most useful less frequently than any other items except the 1:250,000 scale maps.

At the end of their participation in the study, the subjects were asked in the Final Debriefing questionnaire to rank the usefulness of each of the aids available in the simulator cockpit. Figure 3-A-4 shows the frequency with which each item was ranked among the most useful. The ordinate shows the number of subjects giving the items rankings of first or second most useful. Elapsed time was by far the most frequently used, followed by the 1:50,000 scale maps and 1:250,000 scale maps. The FAC was found most useful less frequently, and the range-to-go indicator was least frequently ranked among the most useful items. This was probably because the FAC and range-to-go were only used once each. Thus the subjects experienced they only 1/6 as many times as the other aids.

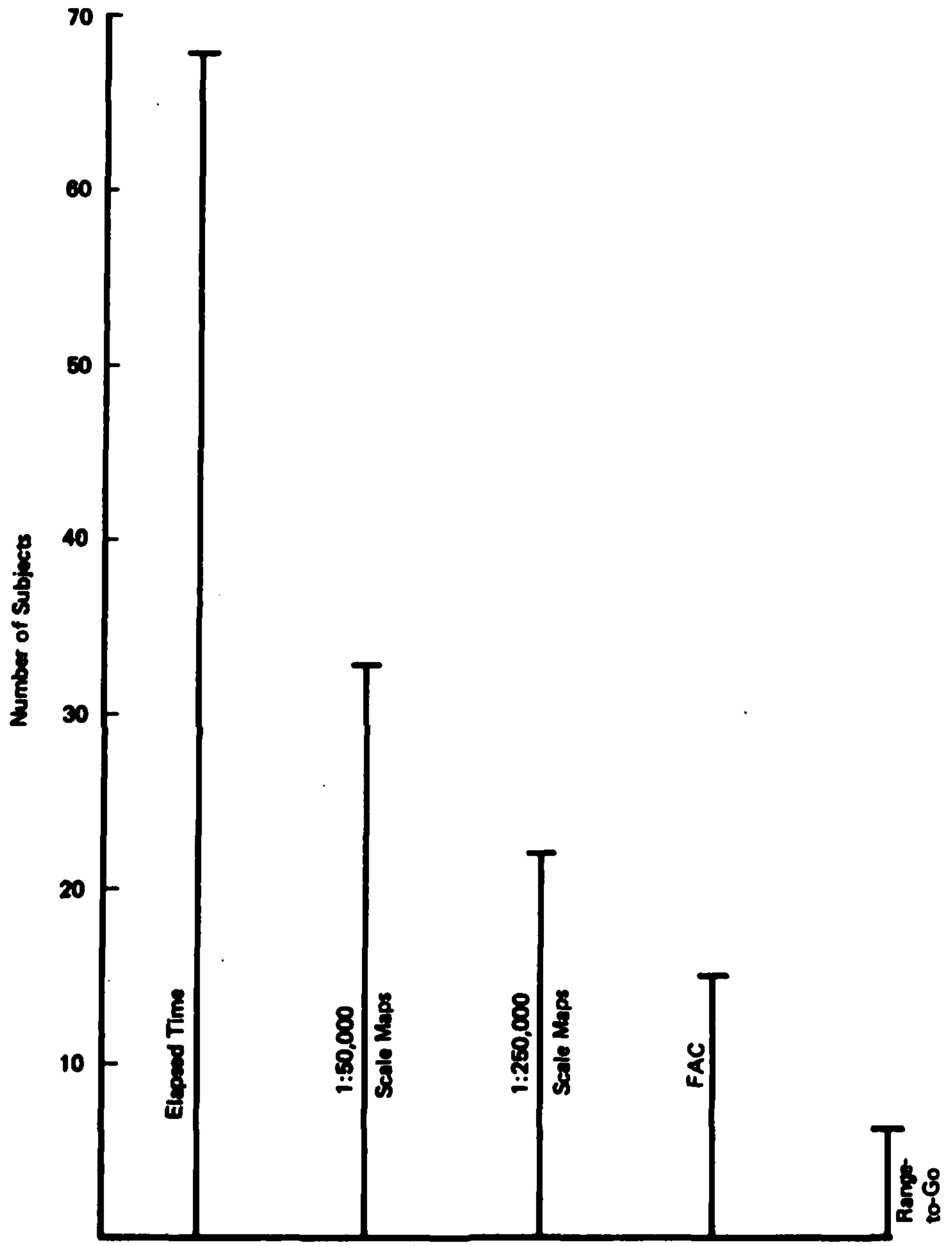

Figure 3-A-4: Most Useful In-Flight Aids

APPENDIX 3

ANNEX A

TAB B

DEBRIEFINGS FROM COMPLEXITY AND AMBIGUITY STUDIES

1. INTRODUCTION

Each subject filled out a debriefing questionnaire following the completion of the Complexity and Ambiguity Studies. The questionnaires are shown in Figures 3-A-5 and 3-A-6. No debriefing questions were asked in the Static Detection Study.

2. COMPLEXITY STUDY

Subjects were asked whether they thought it was more difficult to search for targets in uniformly forested terrain with only a few clearings than it was to search for targets in relatively large open areas with many man-made features. Fifty-five of the 100 subjects responded that it was more difficult to search in uniformly forested terrain, and 44 said it was more difficult to search in large open areas. There was one uncommitted answer. It is interesting to note the disagreement as to what makes search more difficult. Type of mission and speed of aircraft may have an effect on the pilot's search for targets in specified types of terrain.

When asked on what basis they made their choice for the easier search scene, 48 subjects listed "cleared open areas" and 24 subjects listed "number of cultural/man-made features." "Terrain and ground color" was listed by 26 subjects, and 24 subjects listed "uniformity of terrain/flat terrain." The remainder of the responses are shown in Table 3-A-1.

3. AMBIGUITY STUDY

Table 3-A-2 lists the types of things counted by the subjects as target-like objects.

The subjects were asked to rate their ability to acquire tactical targets based on their operational experience. Sixty-three of the 100 subjects rated their ability as average, 27 above average and 10 below average.

DEBRIEFING QUESTIONS - COMPLEXITY STUDY

a. Considering your choices on the answer sheets, do you think it is more difficult to search for targets in uniformly forested terrain with only a few clearings than it is to search for targets in relatively large open areas with many man-made (i.e. cultural) features? Explain briefly.

b. On what basis did you make your choice for the easier search scene?

Figure 3-A-5

DEBRIEFING QUESTIONS - AMBIGUITY STUDY

Please list the types of things that generally made up your count for the scenes just presented.

How do you rate your ability to acquire tactical targets based on your operational experience?

Above average

Average

Below average

Figure 3-A-6

TABLE 3-A-1 FACTORS CONTRIBUTING TO EASIER SEARCH SCENE

RESPONSE	NUMBER OF SUBJECT RESPONSES
Cleared - Open Areas	48
Terrain - Ground Color	26
No. Cultural, man-made features	24
Uniformity of Terrain/Flat Terrain	24
Track Activity - Trails, Roads, Highways	20
Height - Density of Forest	20
Contract - Shadow	19
Weather - Clouds, Clarity, Light, Sky Conditions	12
Amount of Sorting/Confusion	11
Tree Lines/Amount of Area to Search/Division of Terrain into Sectors/Geometric Relationship	10
Practical Experience - "Gut Feeling"	9
Angle of Observation/Aircraft Attitude	9
Camouflage - Type of Cover	5
Rivers, Lakes, Waterways	4
Lack of Physical Access to an Area	3
Breaks in Forest/Cultural Features	2
Reference Points	2
Time to Acquire Target	1
Size of Search Area	1
Aircraft Altitude	1
No Response	3

TABLE 3-A-2 TYPES OF THINGS COUNTED AS TARGET-LIKE OBJECTS

RESPONSE	NUMBER OF SUBJECT RESPONSES
Roads, Trails, Road Intersections, Tree Lined Roads, Dirt Roads, Dirt Parking Area, Railroad, Vehicle Tracks	77
Vehicles, Tanks, Trucks, Convoys, Cars, Equipment, Troops	73
Man-Made Objects - Buildings, Houses, Stockpiles, Fencelines, Barns, etc.	70
AAA and Missile Sites, Bunkers and Miscellaneous Equipment	65
Clearings - Forest, Tree Lines, Fields, Tree Groups, Foliage Breaks, Concealment Areas, Vegetation Density	56
Shiny Objects, Reflections, Smoke, Shadows	34
Lakes, Streams, Rivers, Bridges, Crossings, Water	32
Color/Contract/Texture Differences	29
Ravines, Contour/Ridgeline Differences, Terrain Features	23
Geometric Shapes (Ground), Objects Evenly Spaced, Straight Lines, Circular Areas, Right Angles	19
Ground Scars, Excavations, Disrupted Vegetation Unnatural Tree Growth	13
Aircraft, Airfield Patterns	8

APPENDIX 4

ANNEX A

TARGET ACQUISITION PERFORMANCE SUMMARIES

Target acquisition performance on each target, in each condition, is summarized in graphic and tabular form in the following pages. Also included are close range photographs and brief descriptions of the 24 targets.

The graphic summaries are ogival curves, generated by the same methodology as that described in paragraph A.4.b.(1) of the main body of this Annex. Each curve is labeled by condition. Responses beyond MAR (maximum available range) were excluded so the curves were fitted to valid responses only. MAR is plotted for each target and the excluded responses are plotted as individuals, coded to indicate the condition in which they were obtained.

The tabular summaries include, for each target, a condition-by-condition breakdown of the following point values: Mean of acquisition ranges only, where misses and premature responses have been excluded; weighted mean acquisition range with misses included as zero range acquisitions and premature responses excluded; the prediction of weighted mean acquisition range based on the regression analysis; SPR; p(correct); p(incorrect); and p(premature).

MISSION 1, TARGET 1

Target 1-1 is a medium antiaircraft battery, located 12.7 nautical miles from IP-1. It is visually available from a range of 6020 feet. The target is composed of six gun positions arranged around the periphery of a 70-meter circle. Each position is a 7-meter revetment. Three of the revetments are empty and three contain 57mm AA guns. The site is in a small clearing beside a gravel road. Approach to the target is over heavy forest.

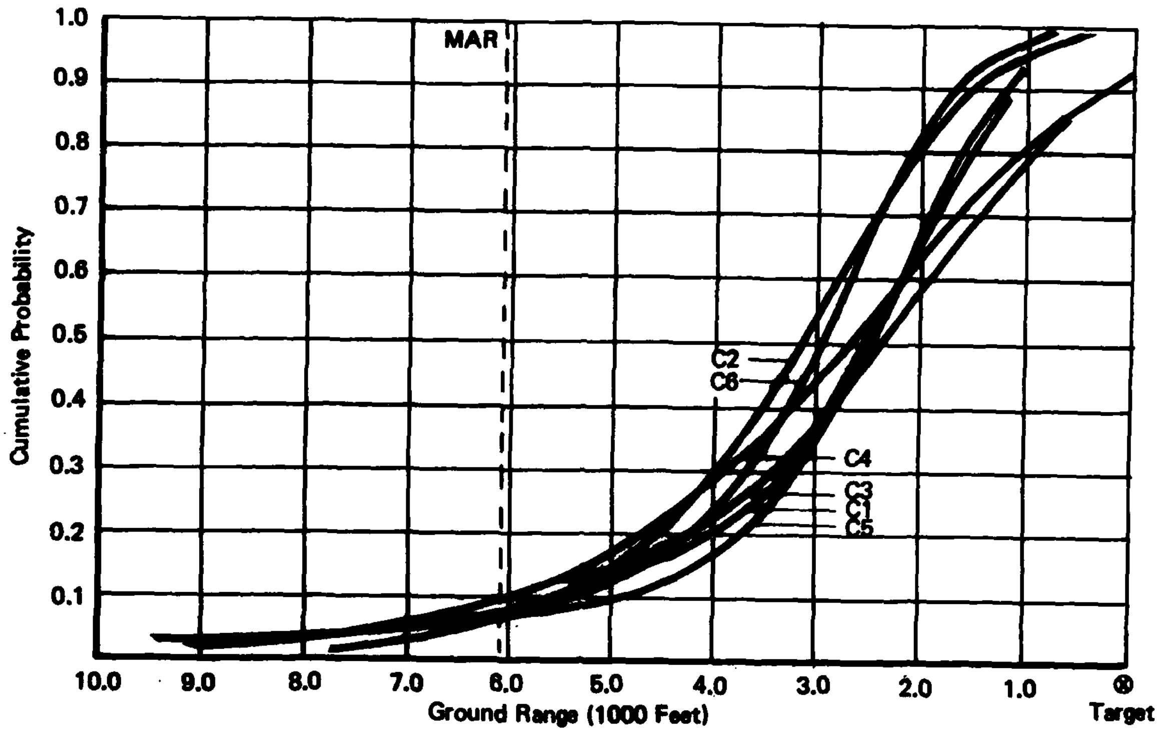

Figure 4-A-1: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 1-1, Medium Anti-Aircraft Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2849	2611	2494	.566	.917	.083	.0
2	FAC	360	Low	3041	3041	3425	.495	1.0	.083	.0
3	None	360	Low	2781	2317	2367	.615	.833	.167	.0
4	None	220	Low	2840	2603	2533	.568	.917	.167	.0
5	None	360	High	2738	2510	2382	.583	.917	.250	.0
6	None	220	High	2959	2959	2923	.508	1.0	.083	.0
All Conditions				2874	2674	2806	.556	.931	.139	.0

MISSION 1, TARGET 2

Target 1-2 is a 152mm howitzer battery, located 5.8 nautical miles west of Target 1-1. It is visually available from a range of 5059 feet. The howitzer battery is composed of 6 revetted positions deployed in a row. Each revetment is 10 meters across and they have 30 meter spearations. Four of the positions are occupied by self-propelled howitzers. The guns are pointed north-northeast. The target site lies in an open brown field on the north side of a highway and is served by a sand road. Heavy vehicle tracks are visible along the revetment row.

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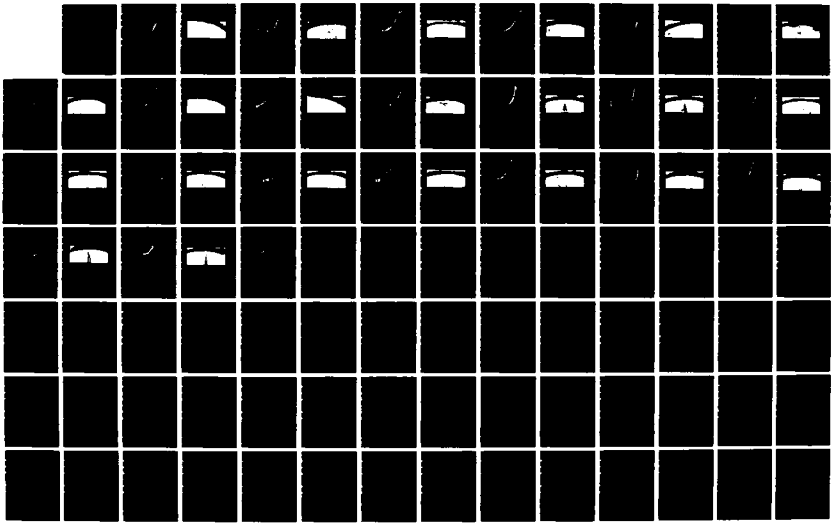

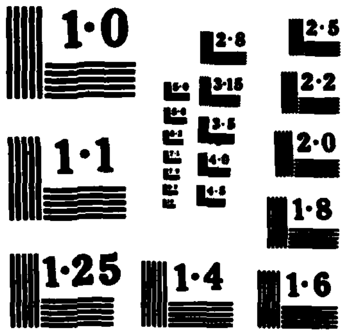
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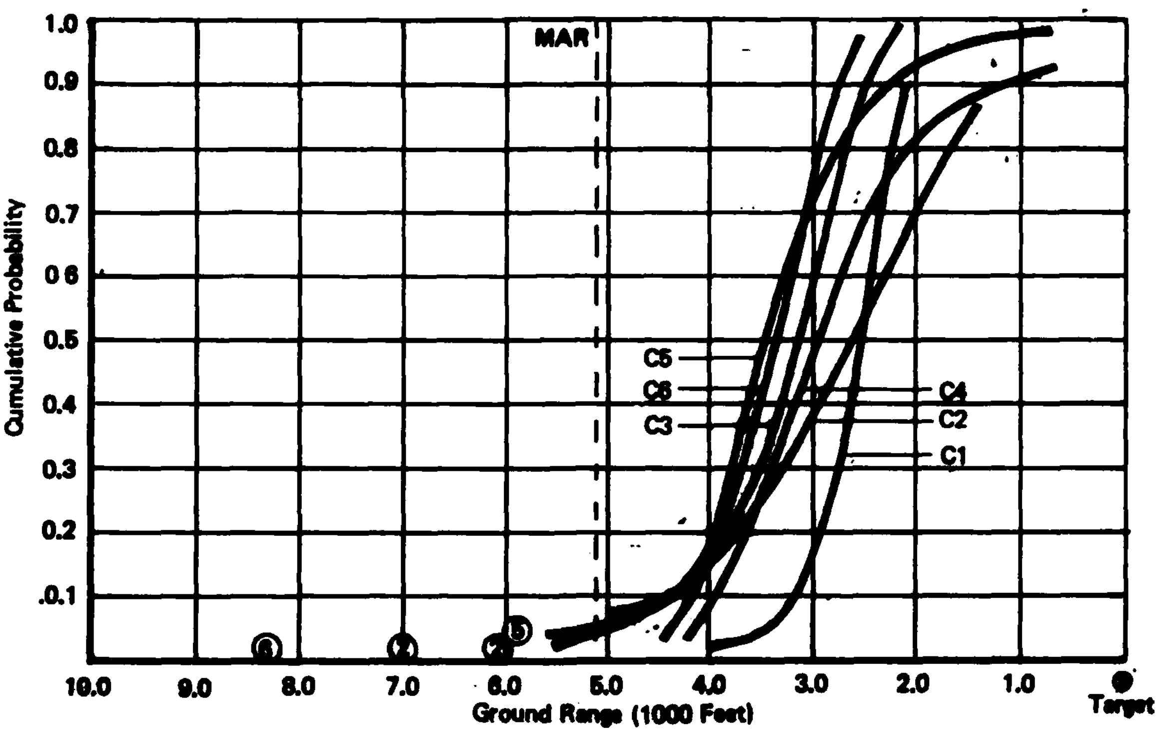


Figure 4-A-2: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 1-2, Self-Propelled Howitzers

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cuing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2572	2358	1969	.534	.917	.083	.0
2	FAC	360	Low	3135	3135	2598	.380	1.0	.0	.167
3	None	360	Low	2853	2378	2238	.530	.833	.167	.0
4	None	220	Low	2820	2585	2350	.489	.917	.0	.0
5	None	360	High	3020	3020	2630	.403	1.0	.083	.083
6	None	220	High	3344	3344	3023	.339	1.0	.0	.083
All Conditions				2956	2782	2461	.450	.944	.056	.056

MISSION 1, TARGET 3

Target 1-3 is a pontoon bridge across a river, located 8.5 nautical miles northwest of Target 1-2. It is visually available from a range of 4628 feet. The bridge is approximately 45 meters long and is comprised of 10 pontoons supporting a single-lane roadway oriented north-south. From either end of the bridge, the road leads into lightly wooded areas. Final approach to the target area is along the river.

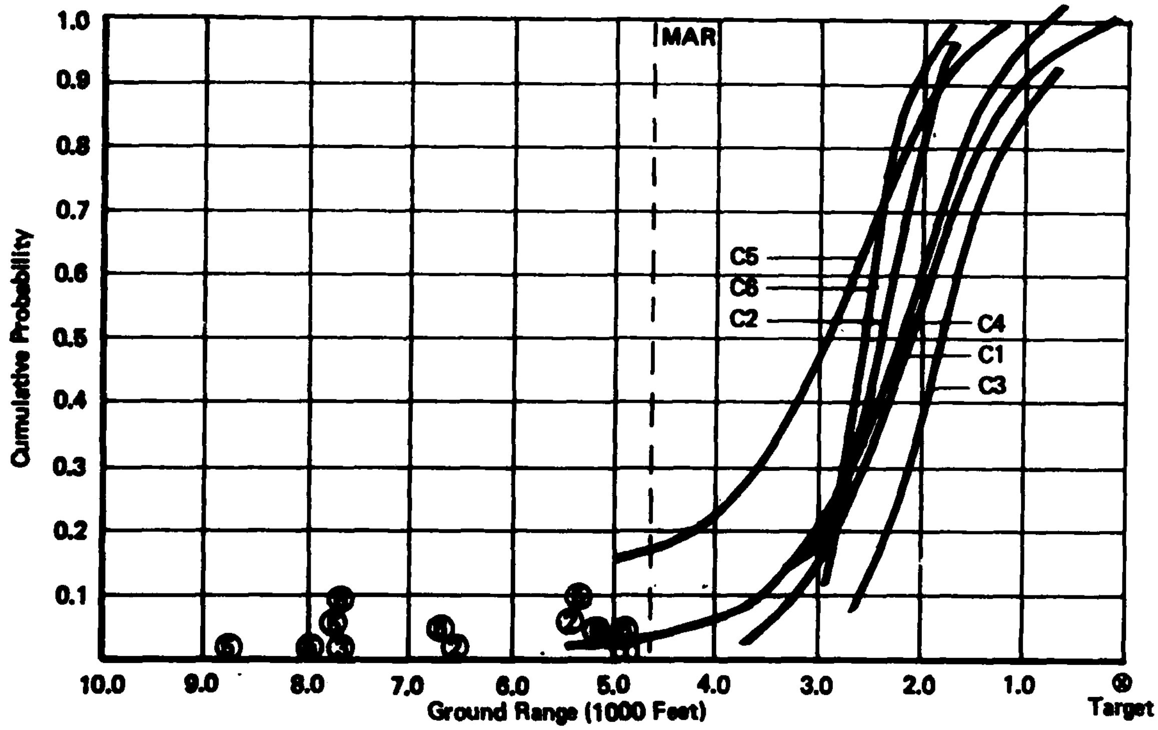
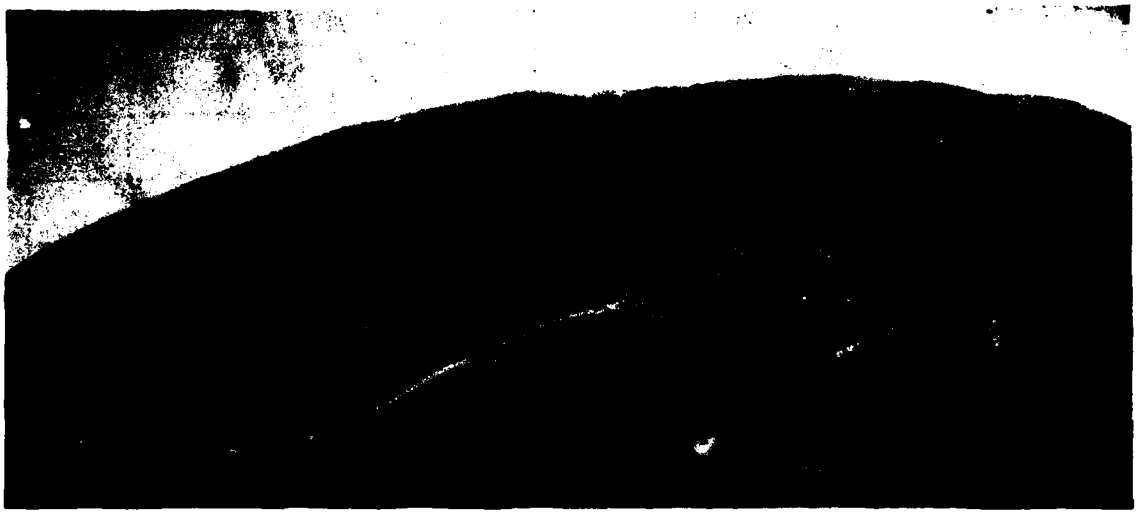


Figure 4-A-3: Target Acquisition Range as a Function of Ground Range, Shown by Conditions, for Target 1-3, Pontoon Bridge

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	1963	1963	2062	.576	1.0	.0	.083
2	FAC	360	Low	2380	2380	1929	.486	1.0	.083	.167
3	None	360	Low	1776	1615	1194	.651	.917	.0	.083
4	None	220	Low	2156	2156	1772	.534	1.0	.0	.0
5	None	360	High	2849	2849	2651	.384	1.0	.0	.417
6	None	220	High	2460	2460	2431	.468	1.0	.0	.250
All Conditions				2222	2185	1975	.528	.986	.014	.167



MISSION 1, TARGET 4

Target 1-4 is a row of 6 howitzers, located 2.7 nautical miles west of Target 1-3. It is visually available from a range of 6393 feet. The 122mm howitzers are in 10-meter diameter revetments in an open field, spaced about 30 meters apart along a row oriented northwest-southeast. Six 2½ ton trucks, the prime movers for the howitzers, are parked along a sand road beyond the row of guns. Target elements are painted olive drab and are moderately visible against the background.

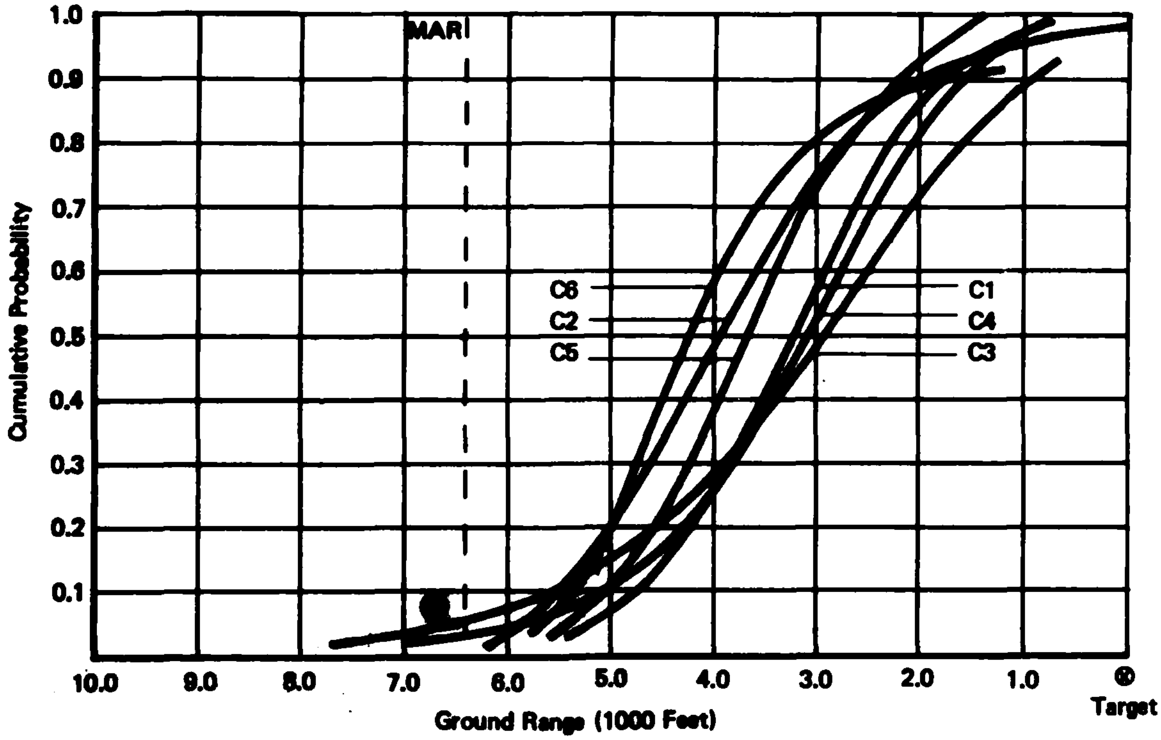
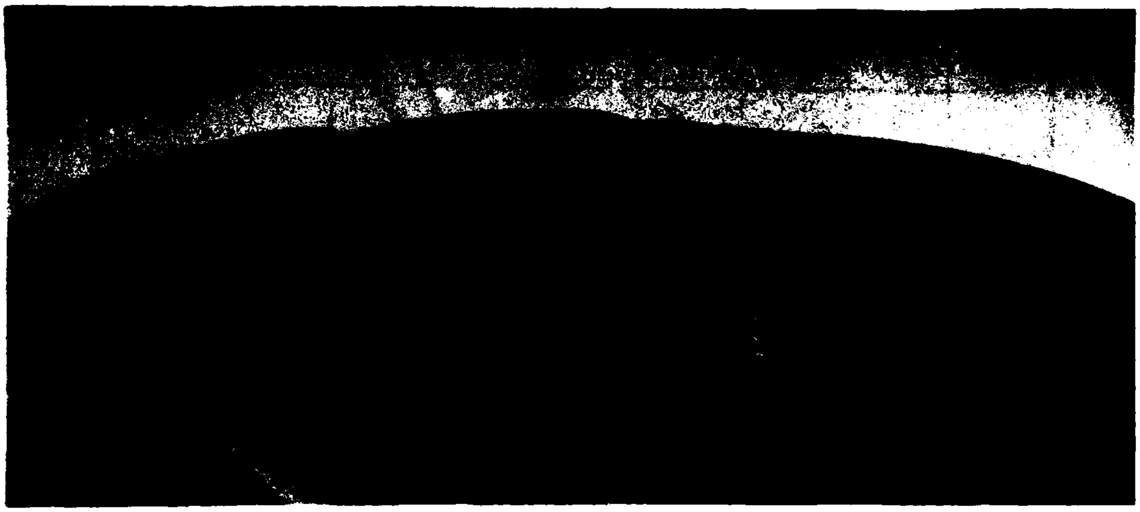


Figure 4-A-4: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 1-4, Towed Howitzers

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cuing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	3056	3056	2818	.522	1.0	.083	.0
2	FAC	360	Low	3569	3569	3762	.442	1.0	.083	.0
3	None	360	Low	3059	2804	3012	.561	.917	.0	.0
4	None	220	Low	2995	2995	3060	.532	1.0	.0	.0
5	None	360	High	3462	3462	3575	.458	1.0	.0	.083
6	None	220	High	4038	3701	3948	.421	.917	.0	.0
All Conditions				3357	3262	3357	.490	.972	.028	.014



MISSION 2, TARGET 1

Target 2-1 is a vehicle park, located 4.9 nautical miles northwest of IP-2. It is visually available at a range of 6876 feet. The vehicle park is composed of 12 armored personnel carriers, two 2½ ton trucks and two jeeps. All vehicles are assembled 60 meters west of a hard surface road in an open field, and tracks are clearly visible.

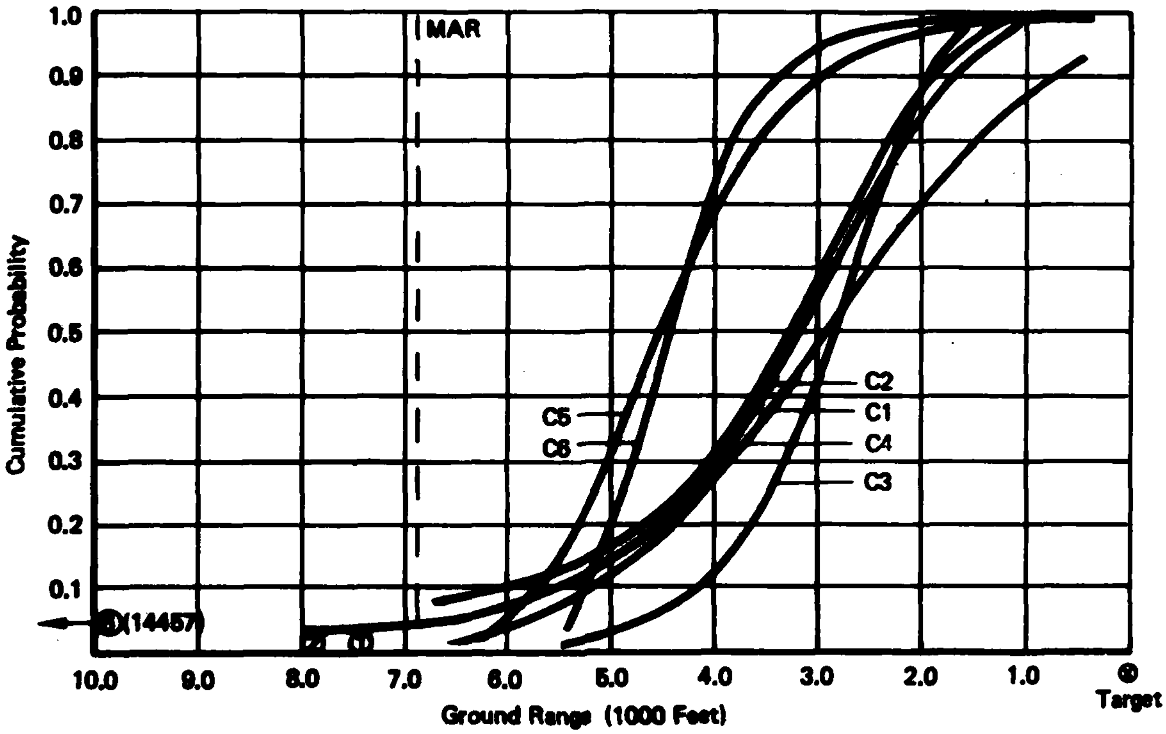
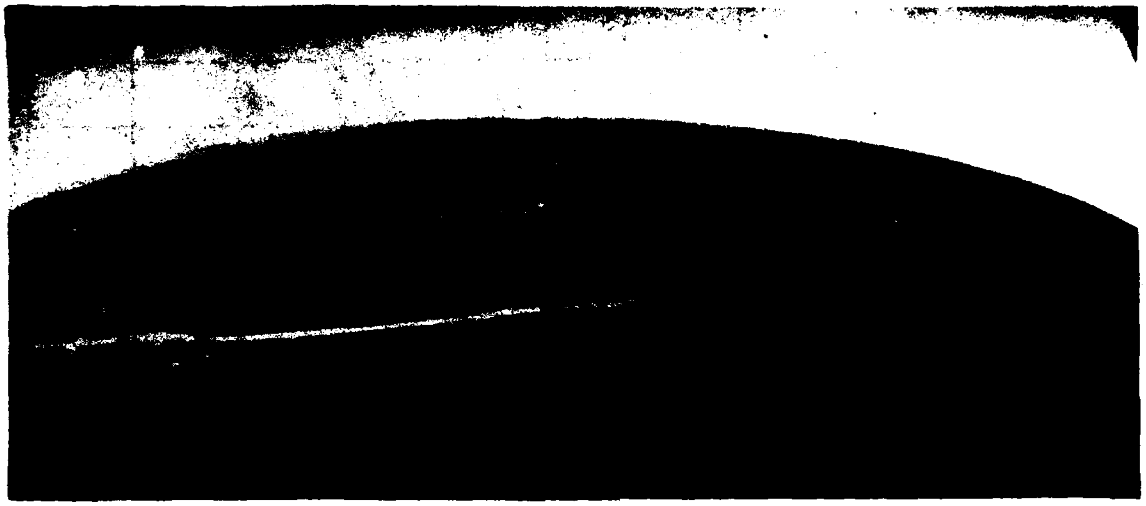


Figure 4-A-5: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 2-1, Vehicle Park

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cuing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	3126	3126	3035	.546	1.0	.0	.083
2	FAC	360	Low	3225	3225	3311	.531	1.0	.0	.083
3	None	360	Low	2809	2809	2394	.591	1.0	.083	.0
4	None	220	Low	2972	2724	2611	.604	.917	.083	.0
5	None	360	High	4119	4119	3805	.401	1.0	.083	.0
6	None	220	High	4189	4189	3895	.391	1.0	.333	.083
All Conditions				3408	3359	3142	.512	.986	.097	.042



MISSION 2, TARGET 2

Target 2-2 is a petroleum, oil and lubricant (POL) site located 20.7 nautical miles from Target 2-1. It is visually available from a range of 3369 feet. Three hundred 55-gallon drums are stacked in 2 rows on either side of an improved dirt road. A flatbed truck and a jeep are parked at the site. The drum stacks are 30 meters long, 3 drums high, and are parallel to the road. The site is in a large open area. Target elements are painted olive drab and are difficult to see against the dark field.

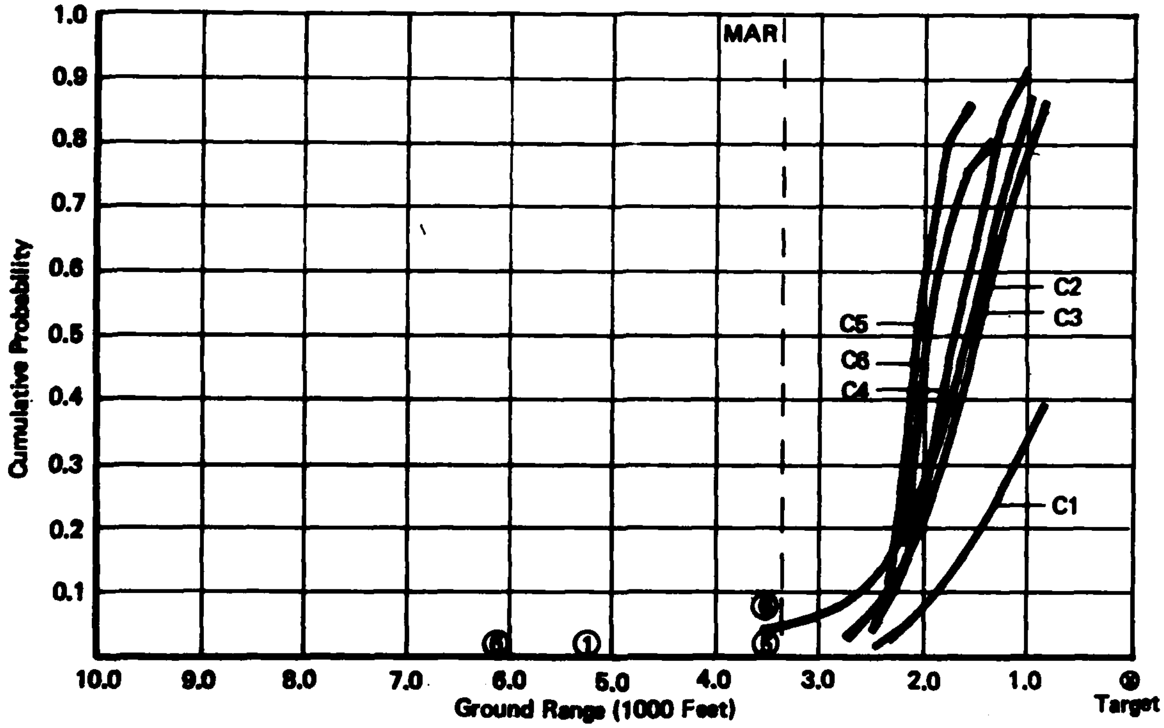
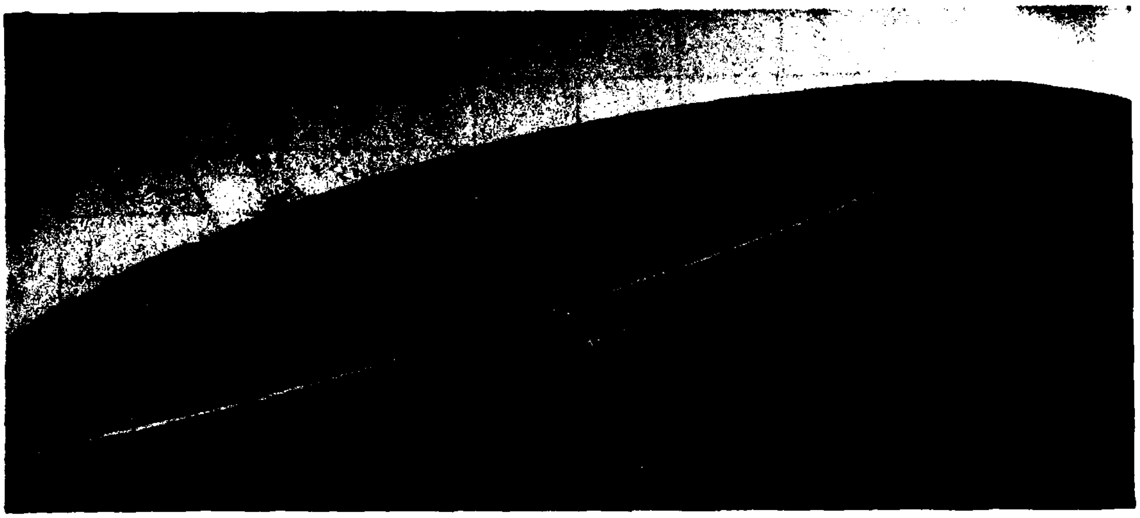


Figure 4-A-6: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 2-2, POL Site

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	1269	577	692	.829	.500	.417	.083
2	FAC	360	Low	1651	1513	1625	.551	.917	.0	.0
3	None	360	Low	1600	1334	1420	.604	.833	.250	.0
4	None	220	Low	1726	1582	1764	.530	.917	.250	.0
5	None	360	High	1935	1583	1610	.530	.833	.0	.083
6	None	220	High	2015	1612	1595	.522	.833	.083	.167
All Conditions				1723	1368	1447	.594	.806	.167	.056



MISSION 2, TARGET 3

Target 2-3 is a heavy (203mm) howitzer battery located 6.5 nautical miles east of Target 2-2. It is visually available from a range of 9658 feet. The site consists of 2 self-propelled howitzers pointed north in open revetted positions 35 meters apart. The revetments are in an east-west line, and the site is centered 45 meters west of a gravel road. An armored personnel carrier is also included in the target. Earth scars from the revetments and heavy interconnecting tracks stand out from the open green field.

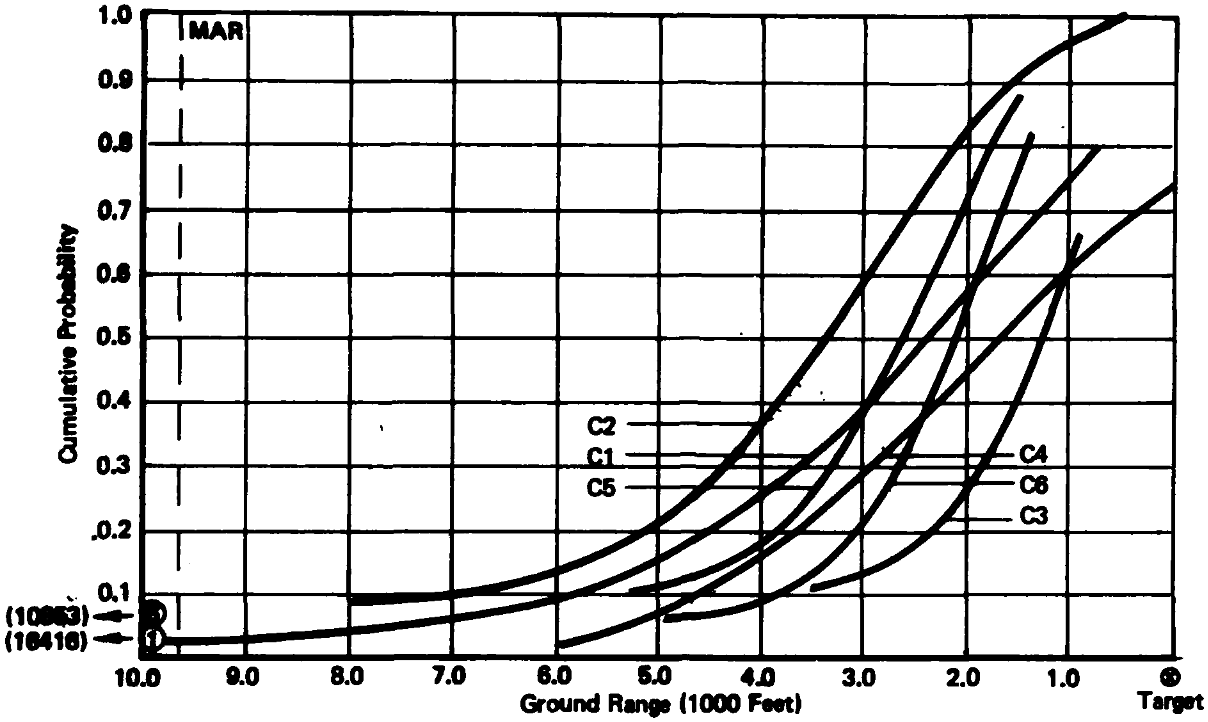
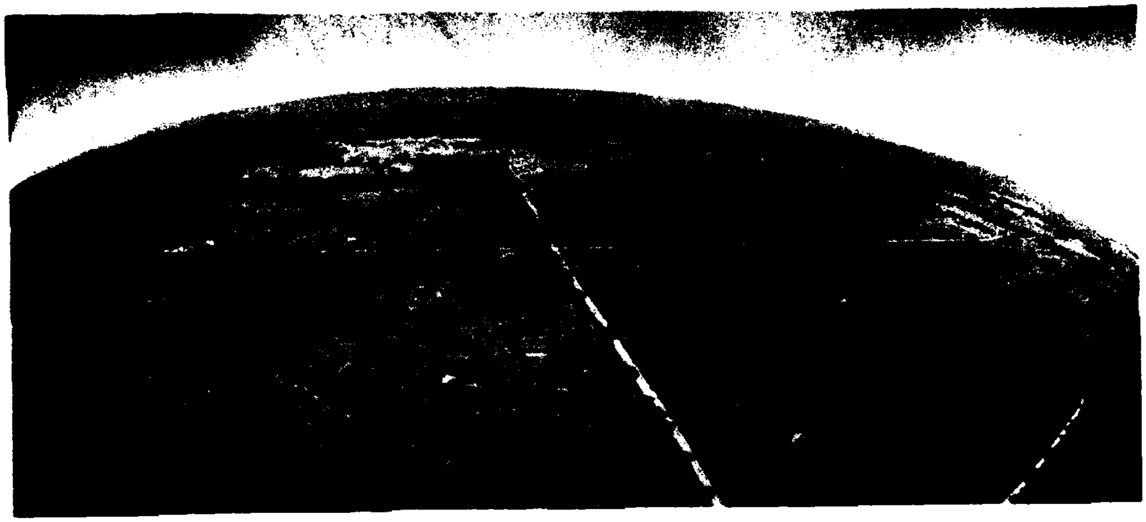


Figure 4-A-7: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 2-3, Howitzer Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2913	2383	2593	.753	.833	.083	.083
2	FAC	360	Low	3328	3328	3941	.655	1.0	.0	.0
3	None	360	Low	2064	1376	2894	.858	.667	.083	.0
4	None	220	Low	2266	1699	2997	.824	.750	.167	.0
5	None	360	High	2878	2638	2965	.727	.917	.083	.0
6	None	220	High	2383	1950	3210	.798	.833	.0	.083
All Conditions				2693	2231	3112	.769	.833	.069	.028



MISSION 2, TARGET 4

Target 2-4 is an occupied helicopter pad located 4.6 nautical miles southeast of Target 2-3. It is visually available from a range of 4721 feet. Two light helicopters are parked 100 feet apart. The pad is about 30 meters south of an improved dirt road and about 30 meters further south is a stack of 55-gallon POL drums. The site is in an open field and no tracks or earth scars are immediately visible.

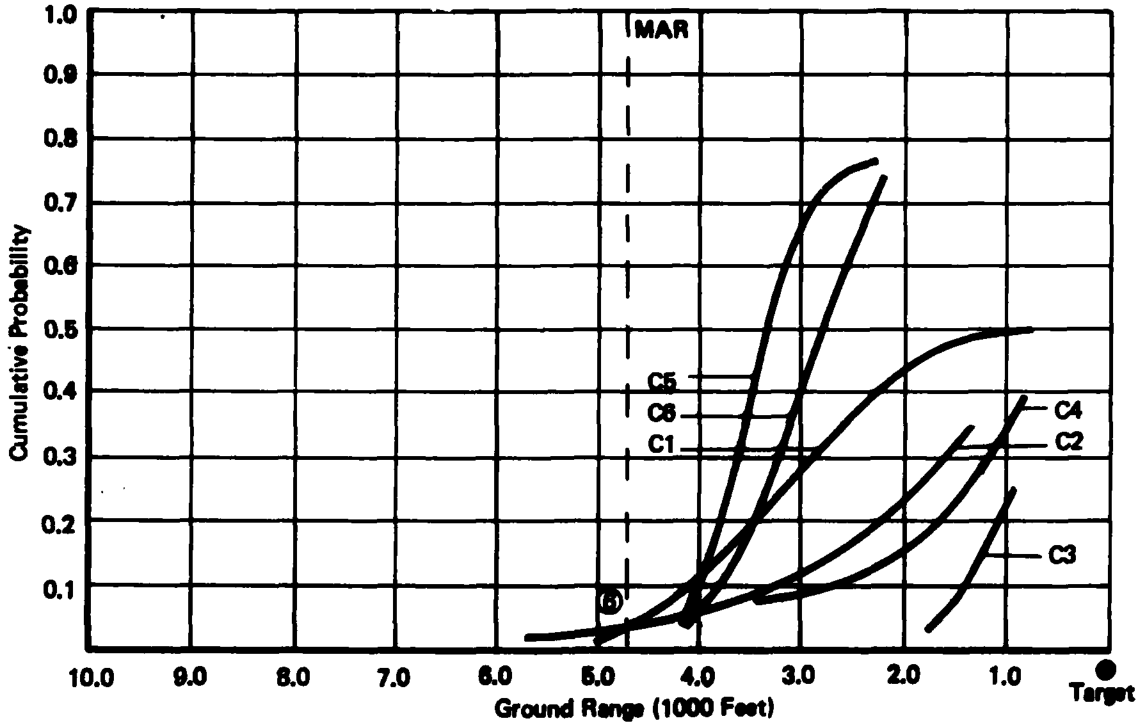


Figure 4-A-8: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions for Target 2-4, Helicopter Pad

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cuing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2834	1417	1574	.700	.500	.167	.0
2	FAC	360	Low	2370	790	1104	.833	.333	.083	.0
3	None	360	Low	1215	304	863	.936	.250	.0	.0
4	None	220	Low	1936	806	1103	.829	.417	.167	.0
5	None	360	High	2993	2245	2419	.525	.750	.0	.0
6	None	220	High	3339	2125	2315	.550	.667	.083	.083
All Conditions				2650	1269	1550	.731	.486	.083	.014

MISSION 3, TARGET 1

Target 3-1 is a tank platoon located 4.1 nautical miles southeast of IP-3. It is visually available from a range of 7080 feet. The platoon is composed of 4 tanks in partial revetments. The revetments are on an east-west line with 30 meter separations. The tanks are deployed in an open field between a highway and a river. A dirt road serves the target area from the north side of the line of revetments, and earth scars from the revetments and interconnecting tracks are visible.

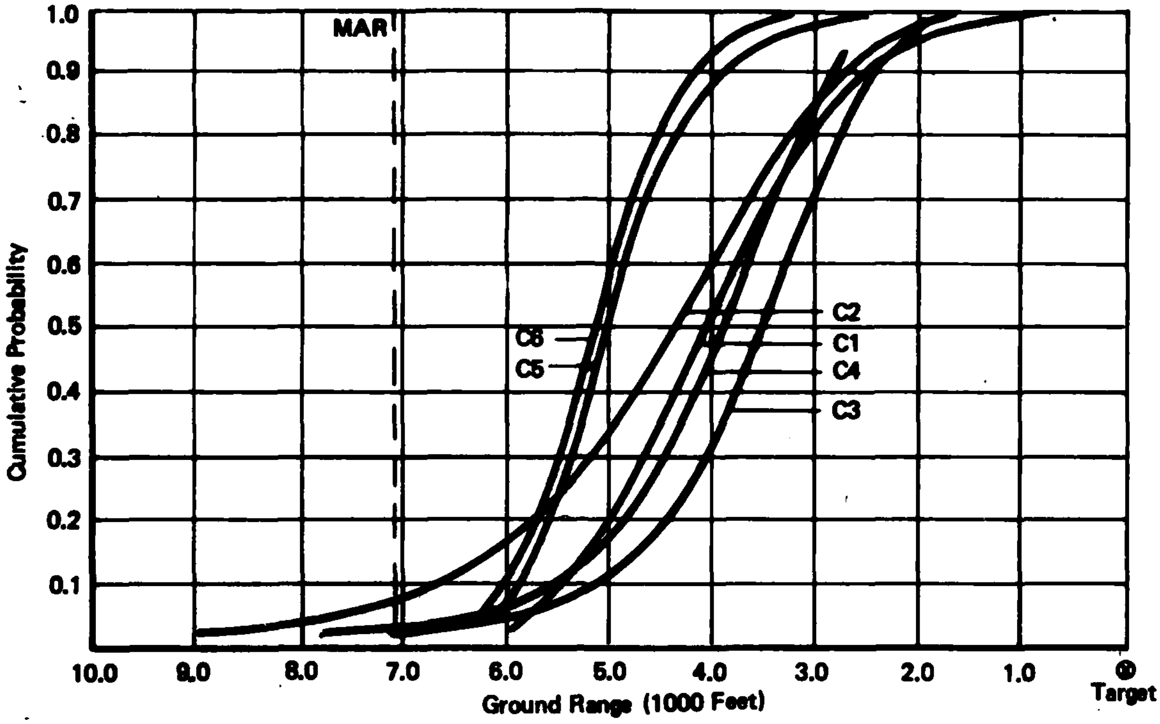
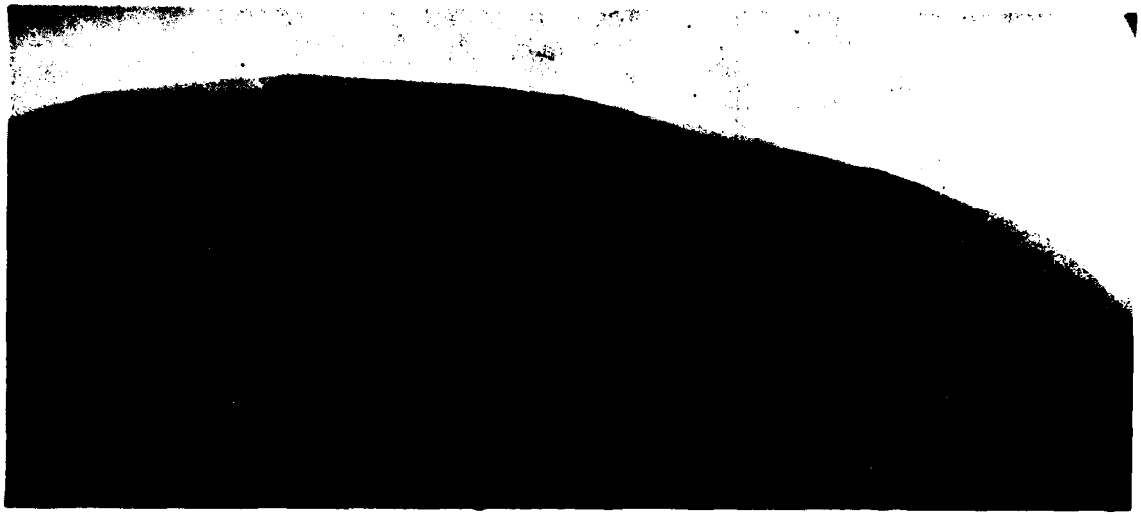


Figure 4-A-9: Target Acquisition Probability as a Function of Ground Range, Shown by Condition, for Target 3-1, Tank Platoon

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	3738	3738	3303	.472	1.0	.0	.0
2	FAC	360	Low	4224	4224	4112	.403	1.0	.083	.0
3	None	360	Low	3435	3435	3353	.515	1.0	.0	.0
4	None	220	Low	3977	3645	3209	.485	.917	.167	.0
5	None	360	High	4761	4761	4458	.328	1.0	.0	.0
6	None	220	High	4957	4957	4841	.300	1.0	.0	.0
All Conditions				4185	4127	3877	.417	.986	.042	.0



MISSION 3, TARGET 2

Target 3-2 is an antitank battery located 3.8 nautical miles southeast of Target 3-1. It is visually available from a range of 7758 feet. The towable antitank guns are located in revetments 40 meters apart and two 2½ ton trucks are parked near the revetments. The site is in a roughly rectangular clearing in an otherwise heavily wooded area. Earth scars are visible but do not stand out well against the green field.

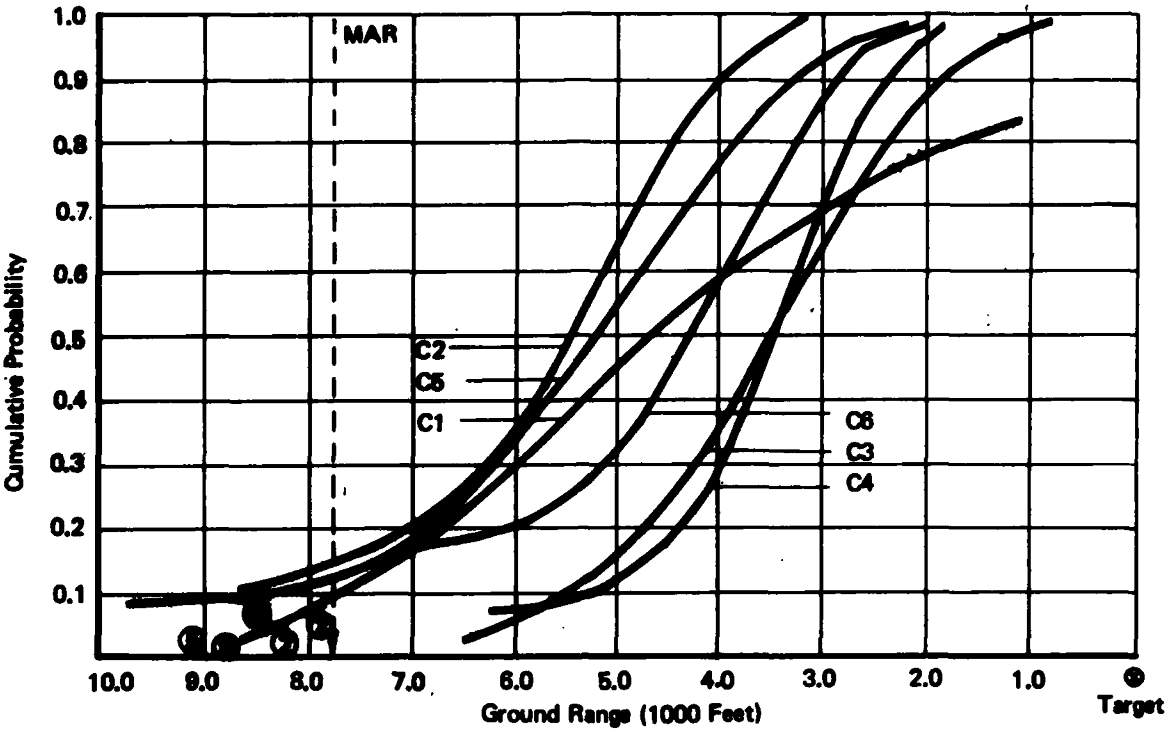


Figure 4-A-10: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 3-2, Anti-Tank Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cuing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	4762	3968	3931	.488	.833	.0	.0
2	FAC	360	Low	5338	5338	4786	.312	1.0	.0	.167
3	None	360	Low	3257	3257	3411	.580	1.0	.0	.0
4	None	220	Low	3371	3371	3838	.566	1.0	.0	.0
5	None	360	High	5044	5044	4680	.350	1.0	.0	.167
6	None	220	High	4341	4341	4666	.440	1.0	.0	.083
All Conditions				4288	4160	4179	.464	.972	.0	.069

MISSION 3, TARGET 3

Target 3-3 is a FROG (free rocket over ground) site located 4.0 nautical miles southeast of Target 3-2. It is visually available from a range of 4293 feet. Four 2½ ton trucks and a surface-to-surface missile on its launcher are parked about 45 meters apart in a roughly pentagonal array. A jeep is parked near the launcher. The target is in an open field west of a highway. Heavy tracks to the vehicle locations are visible. All target elements are painted olive drab.

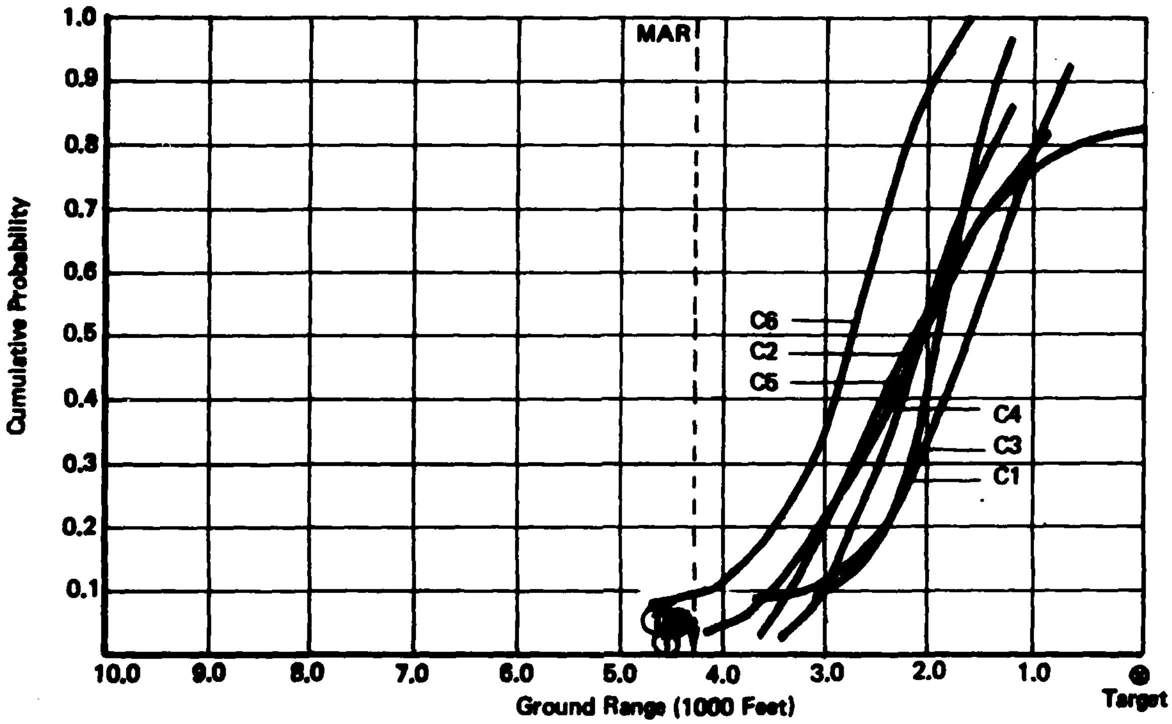
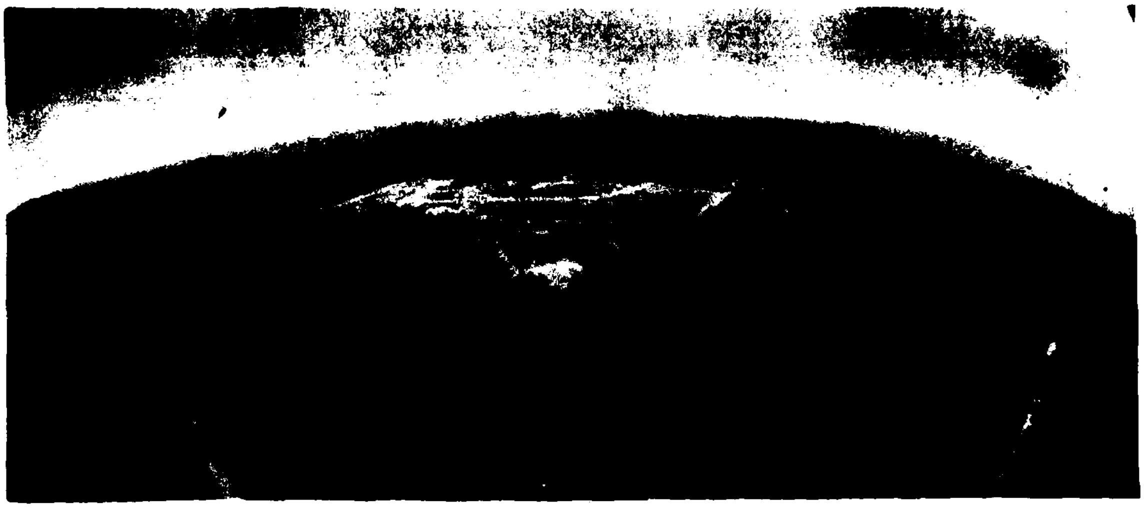


Figure 4-A-11: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 3-3, FROG Site

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	1732	1559	1196	.637	.917	.333	.167
2	FAC	360	Low	2116	1764	1441	.589	.833	.333	.0
3	None	360	Low	2037	2037	1321	.525	1.0	.0	.0
4	None	220	Low	2156	1797	1317	.582	.833	.167	.0
5	None	360	High	2207	1806	1714	.579	.833	.250	.083
6	None	220	High	2705	2705	2068	.370	1.0	.0	.0
All Conditions				2179	1958	1505	.544	.903	.181	.062



MISSION 3, TARGET 4

Target 3-4 is a surface-to-air missile (SAM) site located 14.4 nautical miles east of Target 3-3. It is visually available from a range of 4651 feet. The site contains the following elements: 6 missiles on partially revetted launchers, 7 truck vans, 3 generator vans and a van-mounted radar array. The missiles are silver and all other target elements are painted olive drab. The missiles are located around the periphery of a 215 by 170 meter clearing with the other elements grouped in the center of the clearing. Access tracks join the various target elements. The site is in an isolated clearing in an otherwise heavily wooded area.

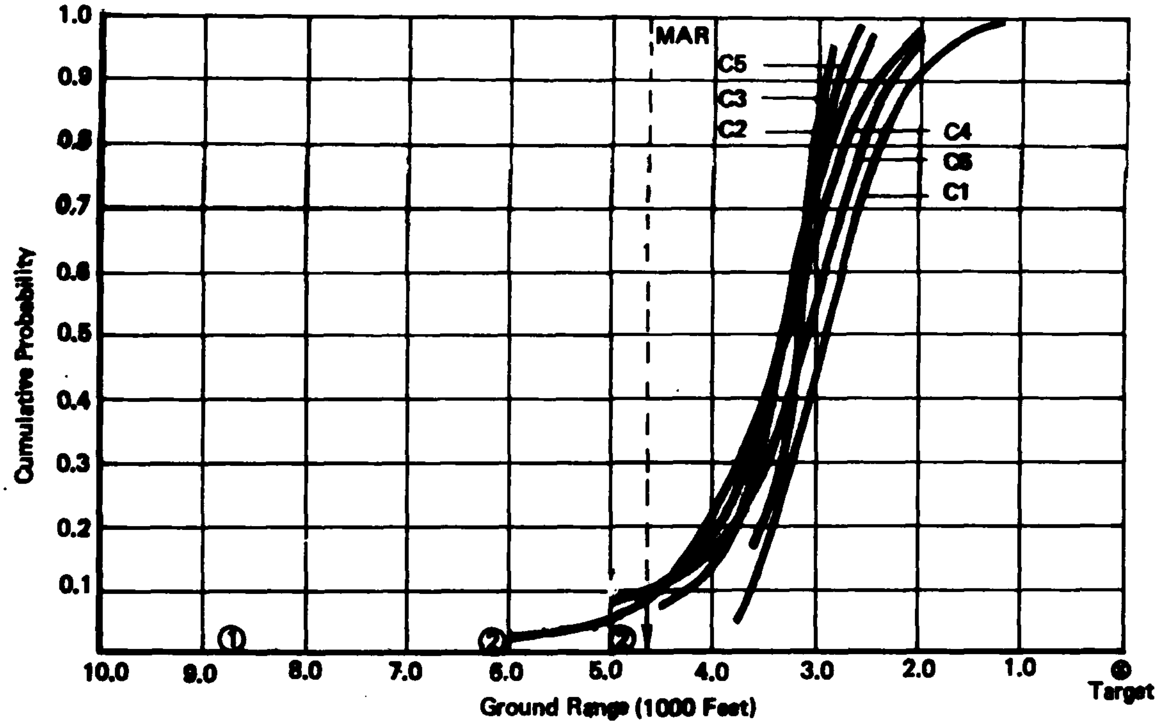
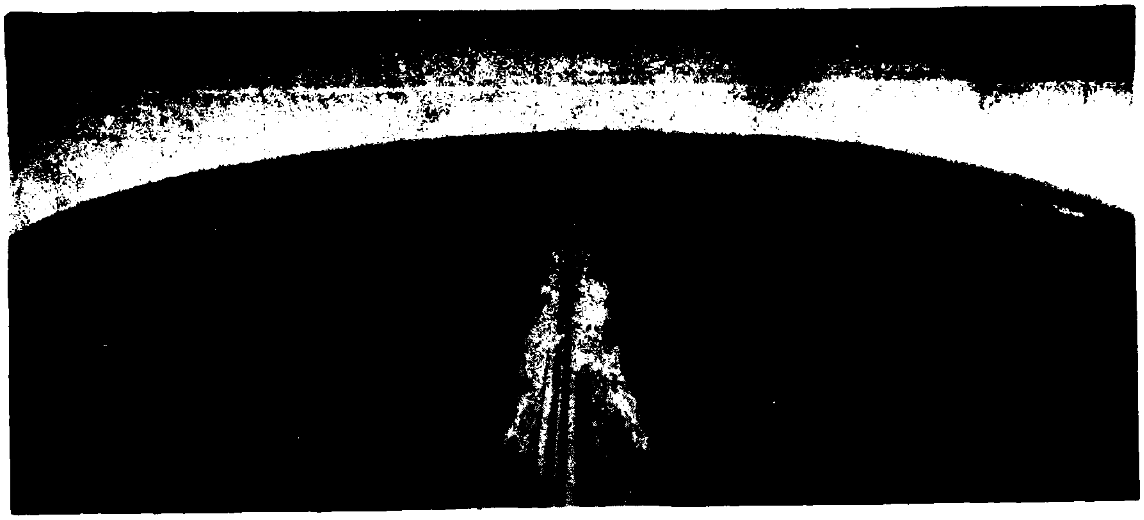


Figure 4-A-12: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 3-4, SAM Site

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2711	2711	1537	.417	1.0	.0	.083
2	FAC	360	Low	3269	3269	2612	.297	1.0	.0	.167
3	None	360	Low	3168	3168	1978	.319	1.0	.0	.0
4	None	220	Low	3236	3236	2053	.304	1.0	.0	.0
5	None	360	High	3295	3295	2282	.292	1.0	.0	.0
6	None	220	High	3044	3044	1977	.346	1.0	.083	.0
All Conditions				3122	3122	2057	.329	1.0	.014	.042



MISSION 4, TARGET 1

Target 4-1 is a tank convoy located 8.2 nautical miles from IP-4. It is visually available from a range of 6586 feet. Five medium tanks are parked on the south shoulder of a highway, with 100 meter separations. The tanks are painted olive drab and are visible against the dirt shoulder.

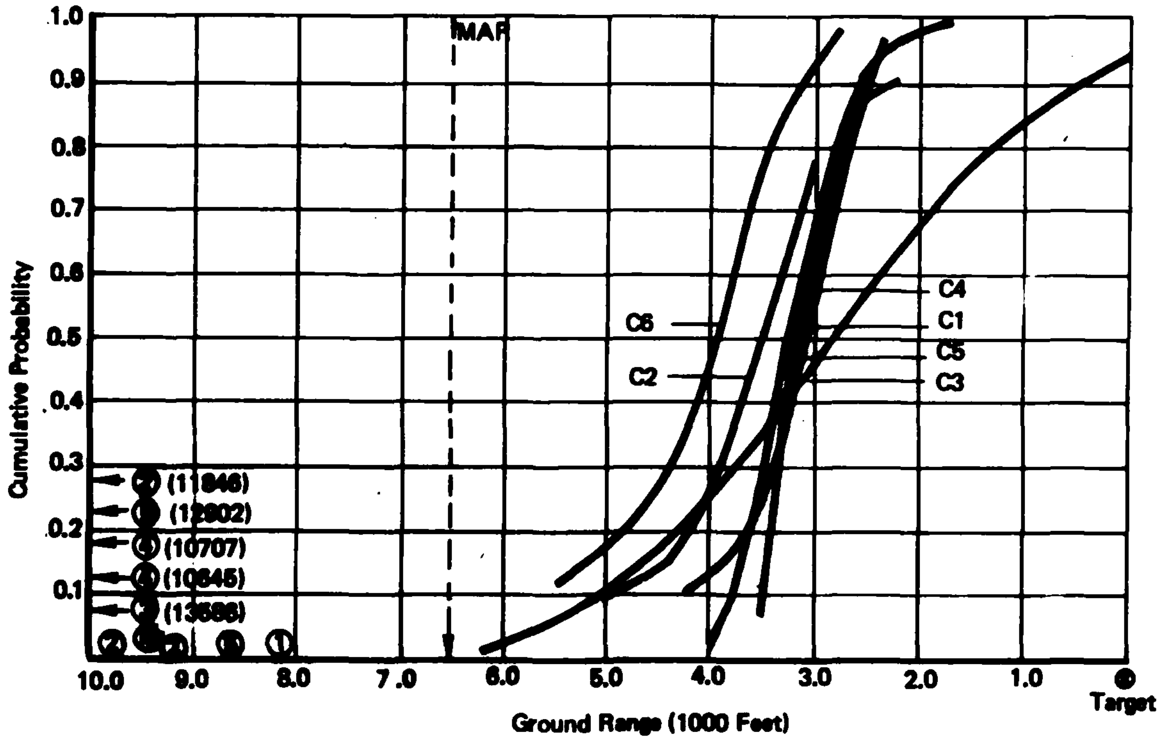
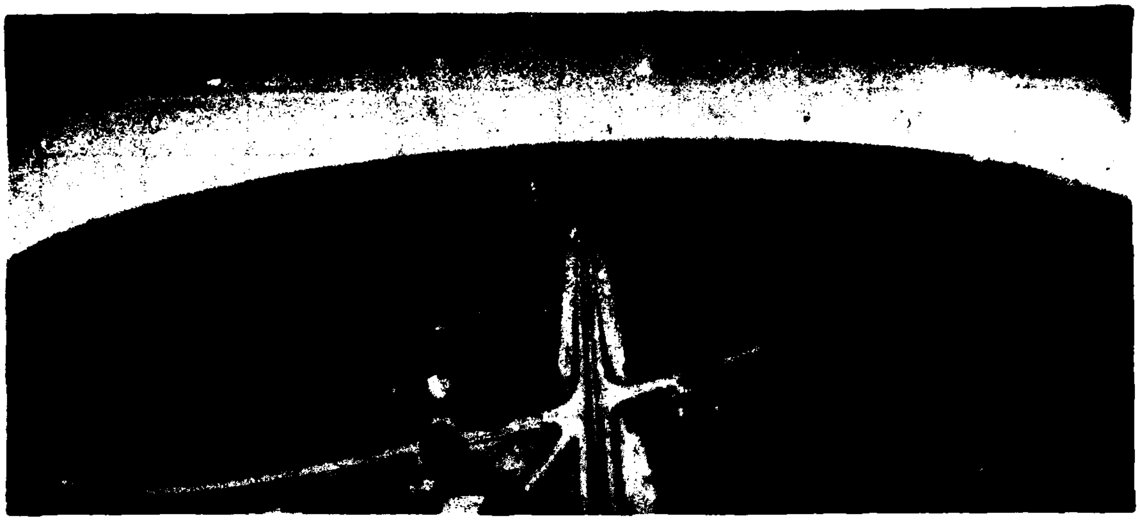


Figure 4-A-13: Target Acquisition Probability as a Function of Ground Range Shown by Conditions, for Target 4-1, Tank Convoy

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	3080	2800	3059	.575	.917	.083	.083
2	FAC	360	Low	3743	3327	3618	.495	.917	.083	.250
3	None	360	Low	2798	2544	2981	.614	.917	.333	.083
4	None	220	Low	3063	3063	3533	.535	1.0	.083	.250
5	None	360	High	3144	3144	3454	.523	1.0	.167	.167
6	None	220	High	4023	4023	4195	.389	1.0	.0	.0
All Conditions				3322	3161	3461	.520	.958	.125	.139



MISSION 4, TARGET 2

Target 4-2 is a vehicle park located 2.6 nautical miles northwest of IP-4. It is visually available from a range of 4535 feet. Thirteen 2½ ton trucks are parked in a roughly rectangular 105 by 115 meter pattern just south of a highway. The site is almost clear of trees. The olive drab trucks and heavy track pattern are visible against the green field grass.

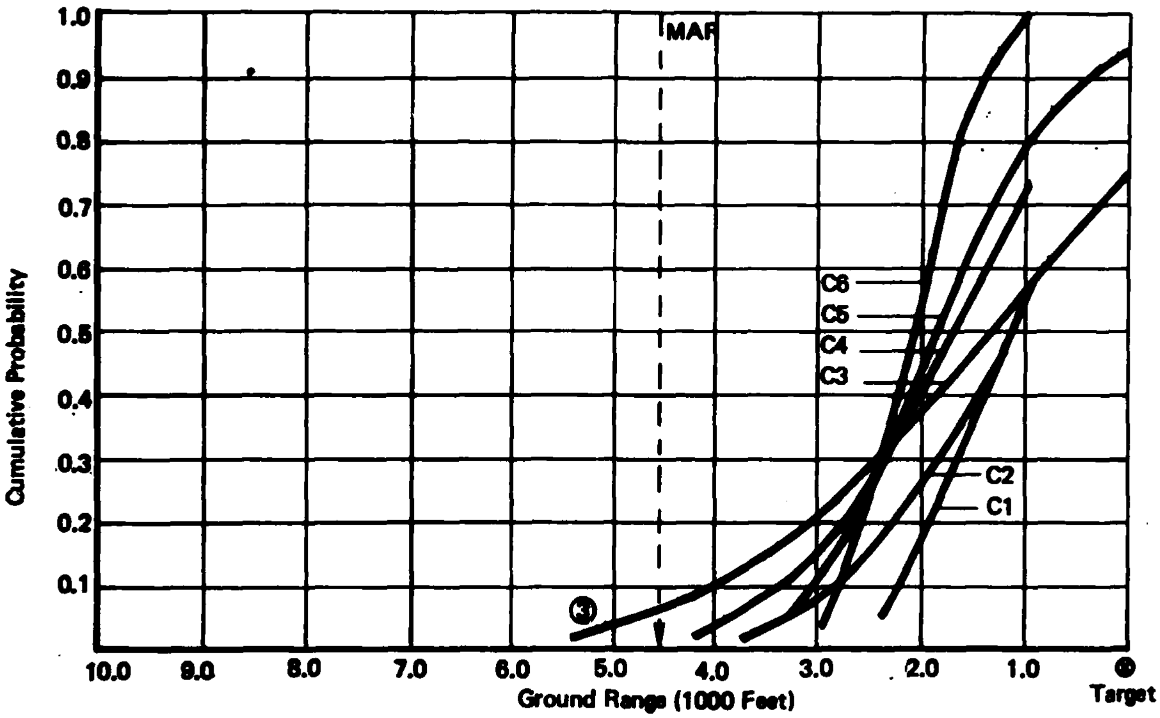


Figure 4-A-14: Target Acquisition Probability as a Function of Ground Range, Shown by Condition, for Target 4-2, Vehicle Park

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	1565	913	1201	.799	.583	.0	.0
2	FAC	360	Low	1943	972	1289	.786	.500	.167	.0
3	None	360	Low	1903	1384	1445	.695	.750	.167	.083
4	None	220	Low	2016	1512	1612	.667	.750	.0	.0
5	None	360	High	1758	1612	1900	.644	.917	.0	.0
6	None	220	High	1940	1940	2365	.572	1.0	.0	.0
All Conditions				1861	1389	1644	.694	.750	.056	.014

MISSION 4, TARGET 3

Target 4-3 is a surface-to-air missile (SAM) site located 8.4 nautical miles northwest of Target 4-2. It is visually available from a range of 9092 feet. The site includes four revetted missile launchers with two missiles each placed in an open field in an east-west line with about 20 meters spacing. In a lightly wooded area about 90 meters south of the row of launchers, there is a group of associated vehicles including two 2½ ton trucks, two generator trailers and a guidance radar van. The missiles are painted silver; the other target elements are olive drab and heavy earth scars are visible.

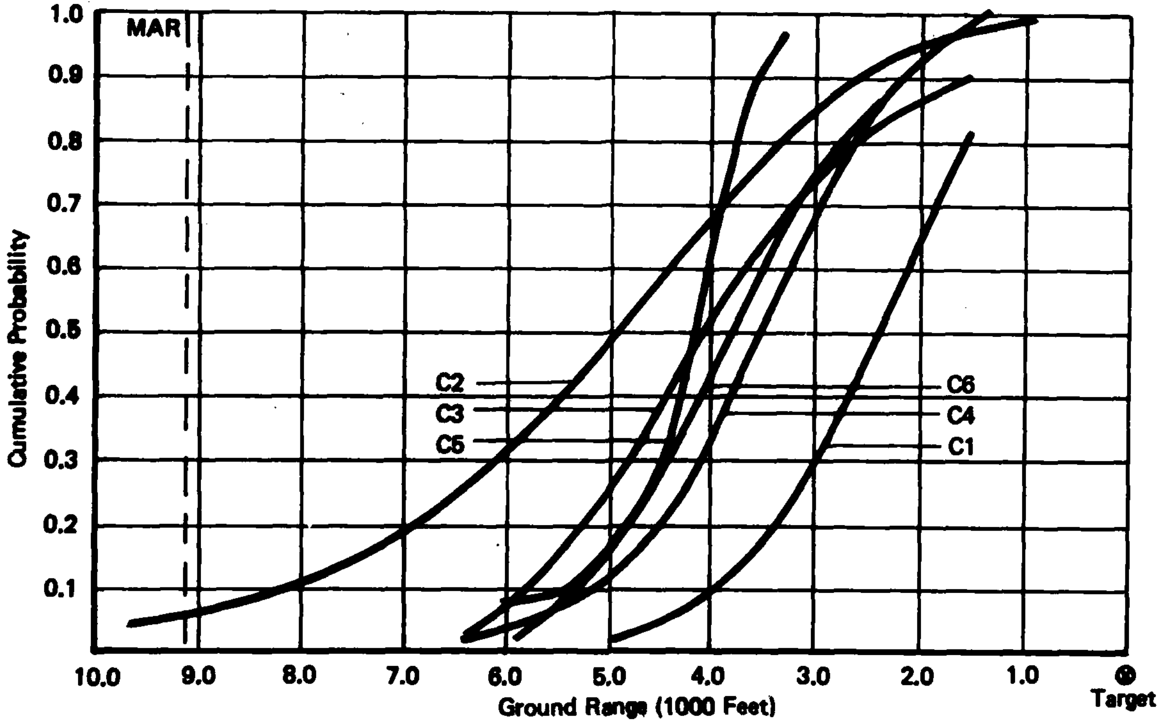
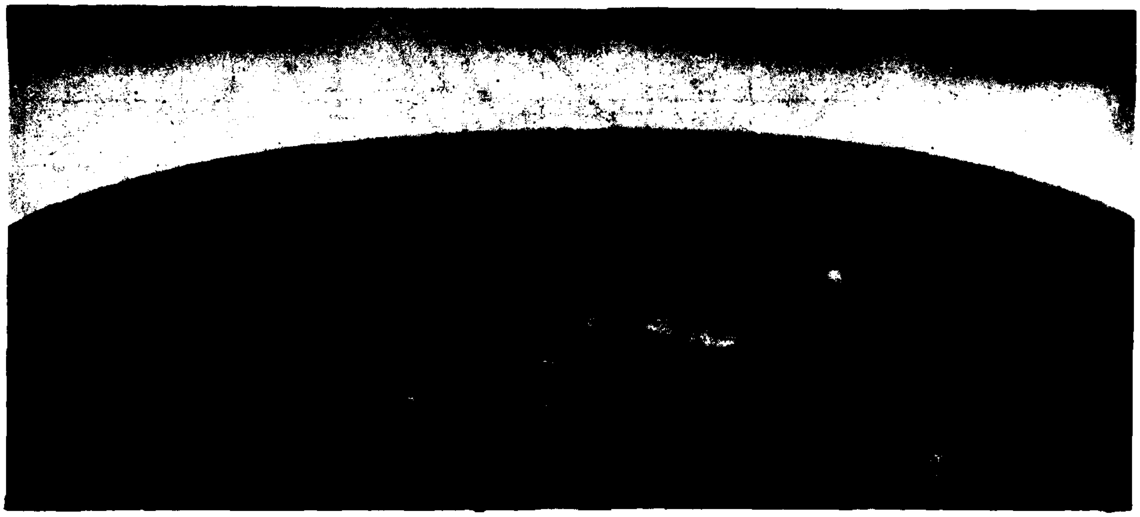


Figure 4-A-15: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 4-3, SAM Site

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2607	2173	3160	.761	.833	.0	.0
2	FAC	360	Low	4749	4749	4804	.478	1.0	.0	.0
3	None	360	Low	3952	3622	3629	.602	.917	.083	.0
4	None	220	Low	3369	3369	3771	.629	1.0	.0	.0
5	None	360	High	3797	3481	4081	.617	.917	.0	.0
6	None	220	High	4256	4256	4130	.532	1.0	.083	.0
All Conditions				3820	3608	3875	.603	.944	.028	.0



MISSION 4, TARGET 4

Target 4-4 is an antiaircraft machine gun unit located 15.4 nautical miles west of Target 4-3. It is visually available from a range of 4287 feet. Two quad 50 caliber machine guns are located in revetments 20 meters apart. They are in an open field 30 meters north of a highway. The olive drab gun mounts and the earthen revetments are visible against the green field.

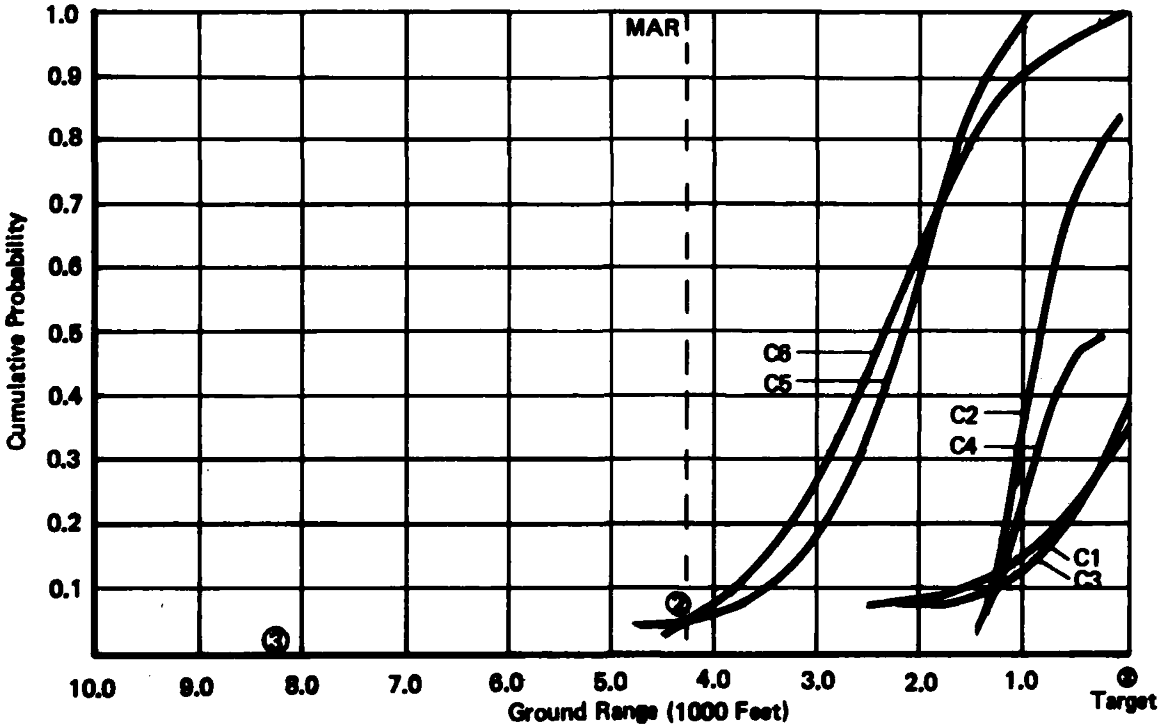


Figure 4-A-16: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 4-4, Anti-Aircraft Machine Guns

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	885	295	1862	.931	.333	.0	.0
2	FAC	360	Low	844	691	2238	.839	.833	.083	.083
3	None	360	Low	953	346	2153	.919	.417	.583	.083
4	None	220	Low	818	409	2087	.905	.500	.0	.0
5	None	360	High	2162	2162	3122	.496	1.0	.0	.0
6	None	220	High	2202	2202	3332	.486	1.0	.0	.0
All Conditions				1537	1032	2453	.759	.681	.111	.028

MISSION 5, TARGET 1

Target 5-1 is a medium antiaircraft battery located 1.5 nautical miles west of IP-5. It is visually available from a range of 5047 feet. The site is composed of a circle of 6 revetments with 4 occupied by 57mm towable antiaircraft guns. Northeast of the gun positions are two more revetments, one containing a fire control director and the other with a van-mounted fire control radar. All target elements are painted olive drab and there are a number of trees in the immediate target area. The battery occupies an area 70 by 85 meters, centered about 110 meters south of a highway.

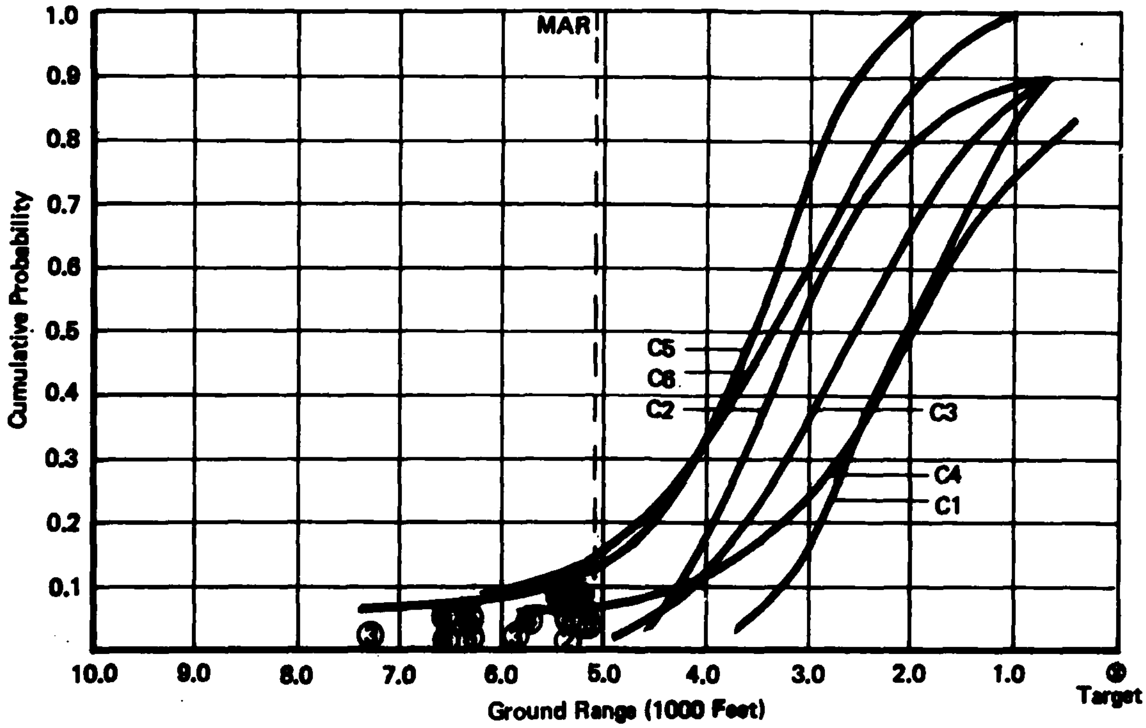


Figure 4-A-17: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 5-1, Medium Anti-Aircraft Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2027	1689	2350	.665	.833	.0	.0
2	FAC	360	Low	2946	2678	2801	.470	.917	.0	.083
3	None	360	Low	2505	2255	2316	.553	.917	.0	.167
4	None	220	Low	2162	1965	2325	.610	.917	.0	.083
5	None	360	High	3491	3491	3350	.308	1.0	.0	.167
6	None	220	High	2996	2996	3522	.406	1.0	.0	.500
All Conditions				2668	2446	2754	.515	.931	.0	.167

MISSION 5, TARGET 2

Target 5-2 is a surface-to-air missile (SAM) convoy located 2.7 nautical miles west of Target 5-1. It is visually available from a range of 7018 feet. Three missiles on transporters are parked on the north shoulder of a highway with 100 meter separations. The missiles are painted silver and are visible against the darker dirt shoulder.

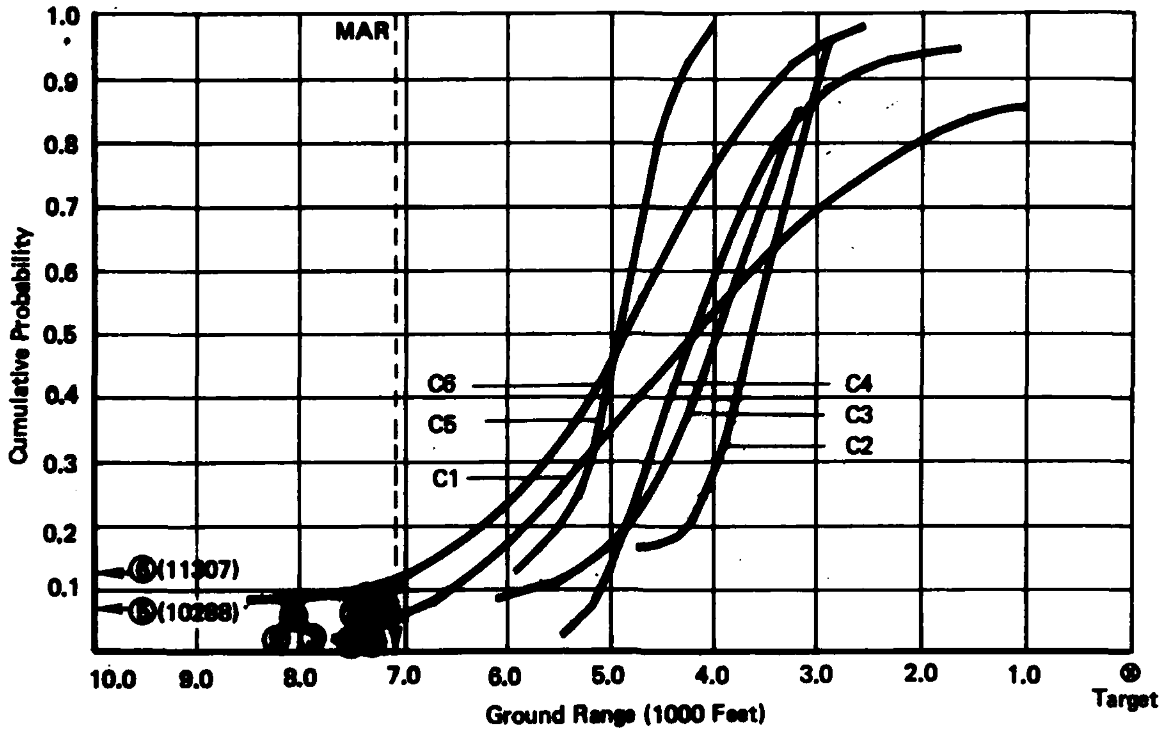
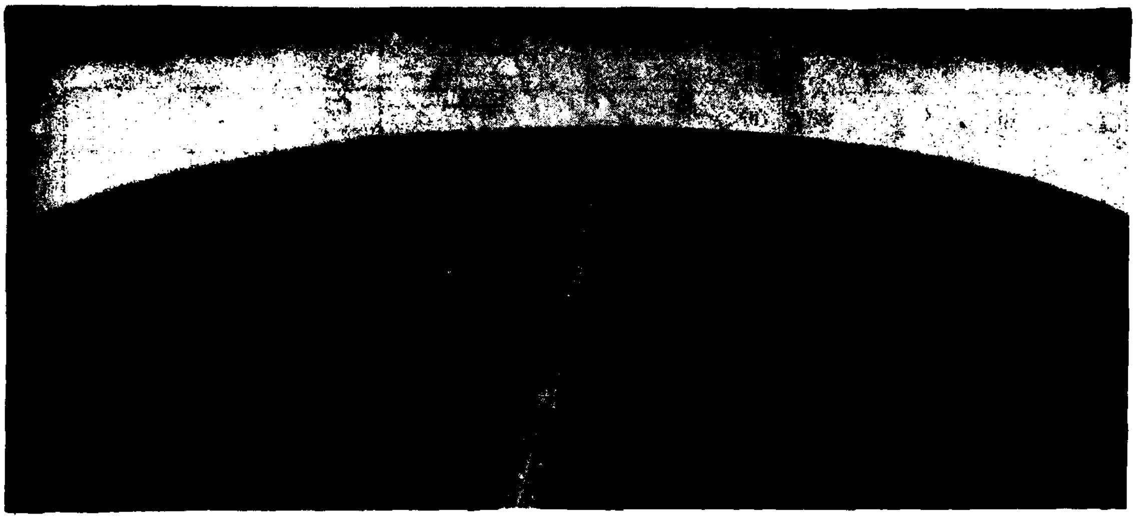


Figure 4-A-18: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 5-2, SAM Convoy

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	4286	3572	3025	.494	.833	.0	.0
2	FAC	360	Low	3644	3644	3549	.484	1.0	.0	.0
3	None	360	Low	4055	3650	2784	.483	.917	.083	.167
4	None	220	Low	3862	3511	3042	.503	.917	.083	.083
5	None	360	High	4866	4866	3978	.311	1.0	.0	.250
6	None	220	High	4695	4695	4171	.335	1.0	.0	.250
All Conditions				4200	3933	3401	.443	.944	.028	.125



MISSION 5, TARGET 3

Target 5-3 is a truck convoy located 19.5 nautical miles west of Target 5-2. It is visually available from a range of 8512 feet. Seven vehicles -- a jeep, four 2½ ton trucks and two 10 ton trucks with trailers -- are parked on the north side of a highway with 100 meter separations. The olive drab vehicles are visible against the road shoulder.

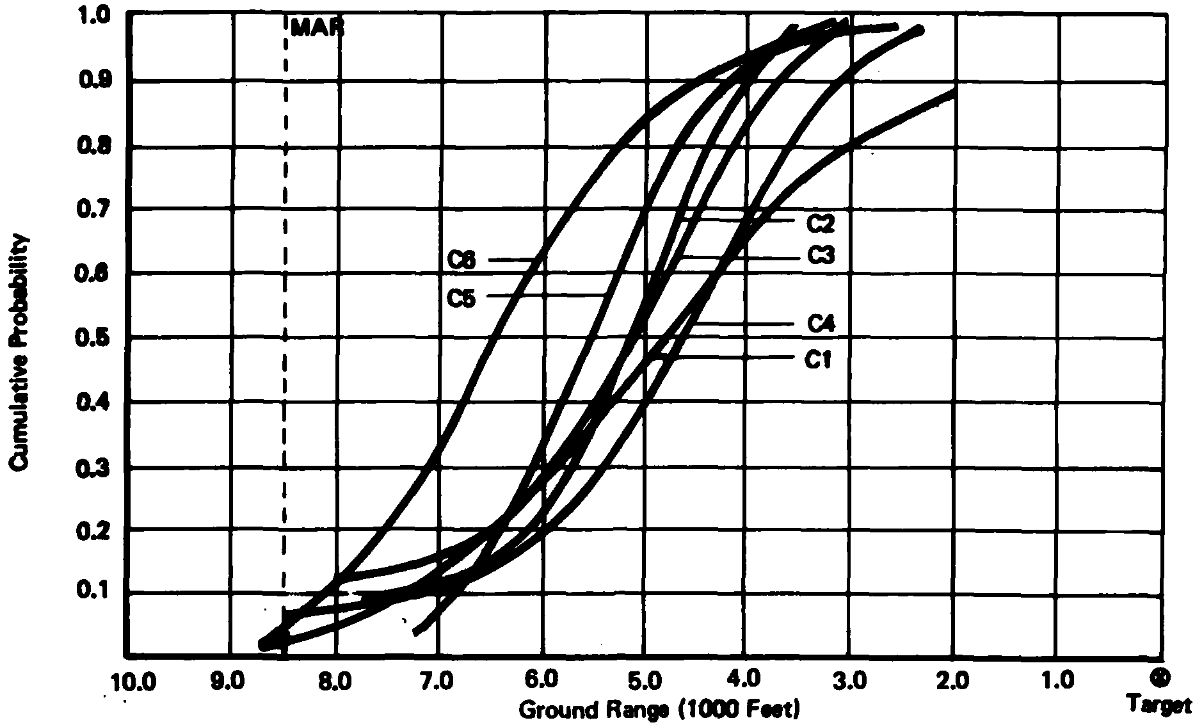
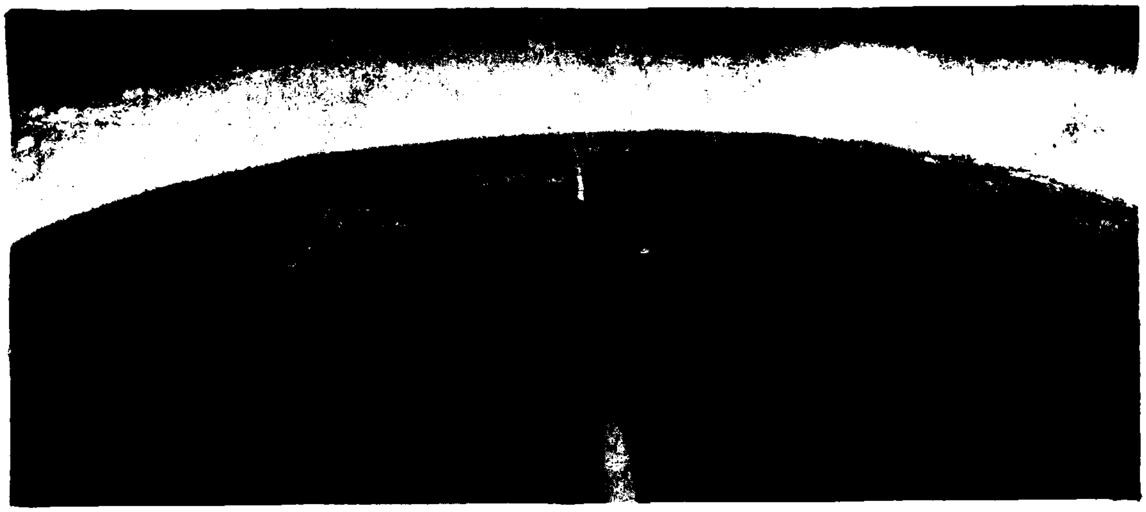


Figure 4-A-19: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 5-3, Truck Convoy

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	5062	4218	2963	.504	.833	.0	.0
2	FAC	360	Low	5150	5150	3516	.395	1.0	.167	.0
3	None	360	Low	5083	5083	2976	.403	1.0	.0	.0
4	None	220	Low	4545	4545	3192	.466	1.0	.167	.0
5	None	360	High	5287	5287	3806	.379	1.0	.0	.0
6	None	220	High	6041	6041	4412	.290	1.0	.0	.0
All Conditions				5198	5054	3478	.406	.972	.056	.0



MISSION 5, TARGET 4

Target 5-4 is a heavy antiaircraft machine gun battery located 13.3 nautical miles from Target 5-3. It is visually available from a range of 3596 feet. It is at the northeast corner of an intersection of two improved dirt roads. The target is in a cloverleaf pattern of four revetments with 20 meter separations between positions. Three of the positions are occupied by quad 50mm machine guns. The target is in a large clear field and occupies an area 35 meters square. The scarred cloverleaf pattern formed by the earth revetments is visible against the green field.

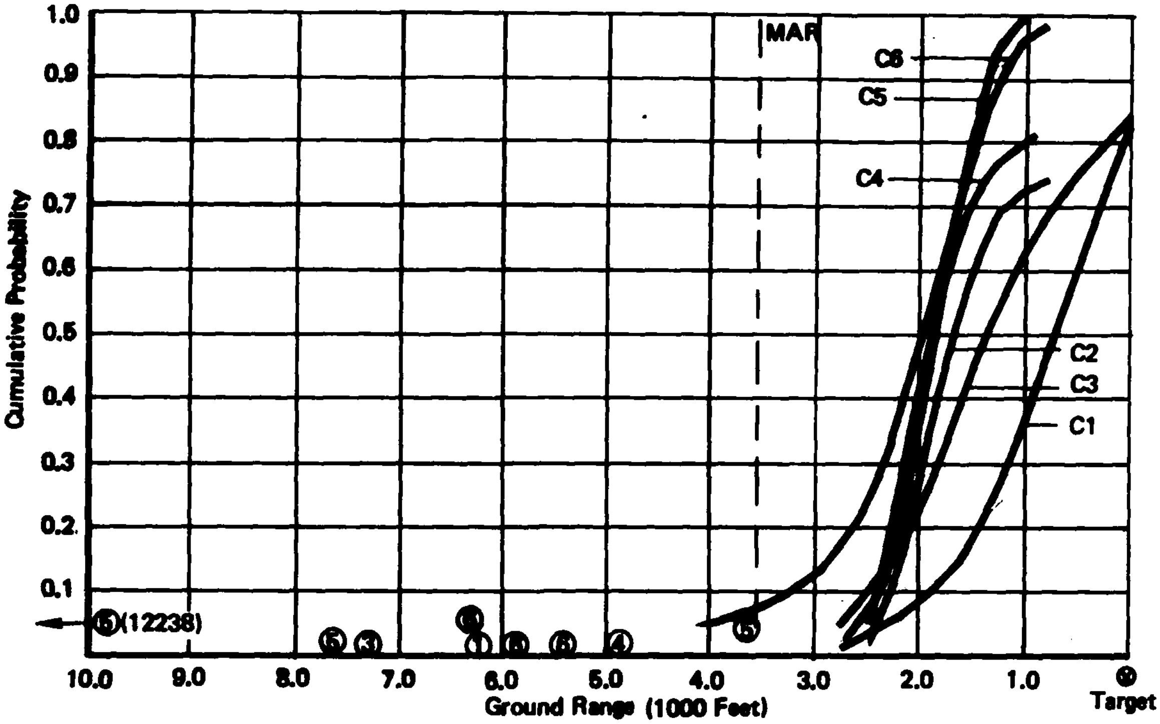
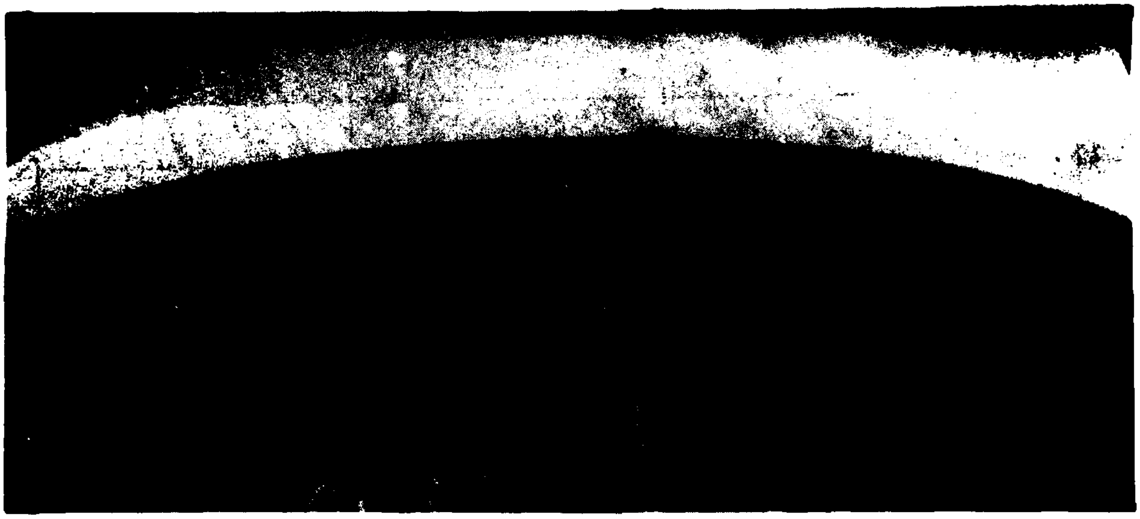


Figure 4-A-20: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 5-4, Heavy Anti-Aircraft Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	881	721	1080	.800	.833	.083	.083
2	FAC	360	Low	1627	1220	1171	.661	.750	.0	.0
3	None	360	Low	1434	1174	1178	.674	.833	.083	.083
4	None	220	Low	1679	1526	1275	.576	.917	.083	.083
5	None	360	High	1774	1774	1949	.507	1.0	.0	.167
6	None	220	High	1882	1882	2069	.477	1.0	.0	.333
All Conditions				1546	1350	1423	.624	.889	.042	.125



MISSION 6, TARGET 1

Target 6-1 is a surface-to-air missile (SAM) convoy located 9.1 nautical miles east of IP-6. It is visually available from a range of 5553 feet. The convoy consists of three SA-2 missiles on transporters. There are 100 meter separations between the transporters which are parked between the road and the railroad track. The missiles are painted silver and stand out well against the grass on which they are parked.

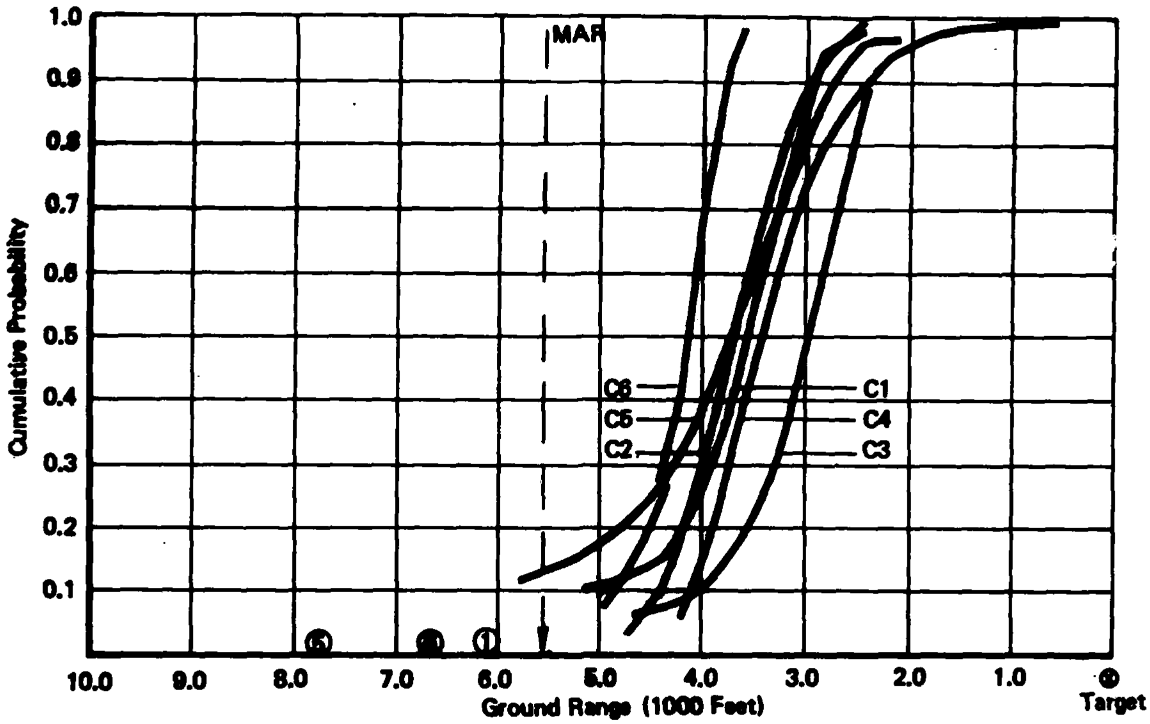
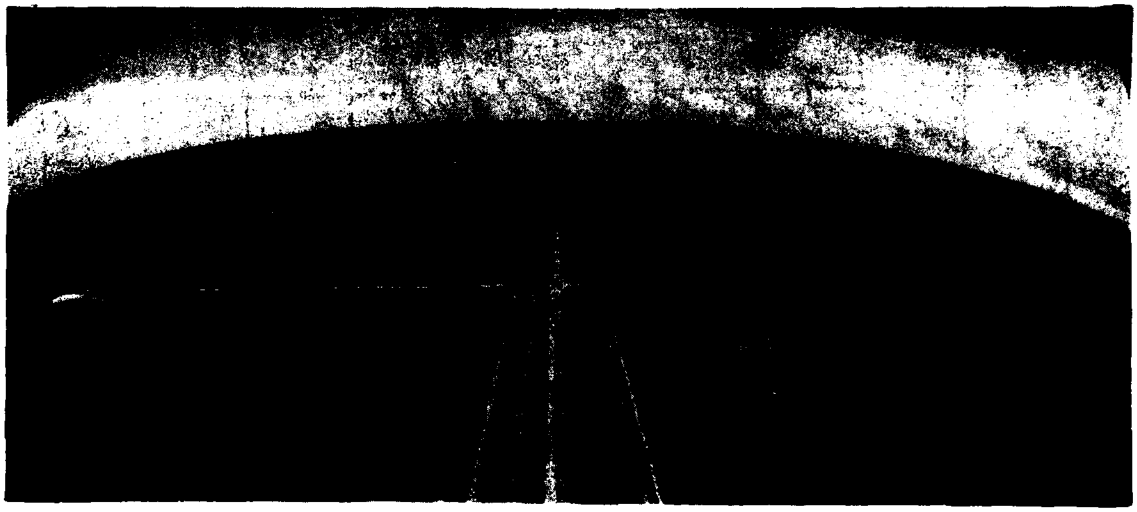


Figure 4-A-21: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions, for Target 6-1, SAM Convoy

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	3648	3648	2554	.343	1.0	.0	.083
2	FAC	360	Low	3598	3598	2729	.352	1.0	.0	.0
3	None	360	Low	3135	2874	2457	.482	.917	.083	.0
4	None	220	Low	3139	3139	2529	.435	1.0	.0	.0
5	None	360	High	3735	3735	3849	.327	1.0	.250	.083
6	None	220	High	4174	4174	4170	.248	1.0	.0	.083
All Conditions				3566	3514	3030	.367	.986	.056	.042



MISSION 6, TARGET 2

Target 6-2 is a battery of light antiaircraft guns located 7.0 nautical miles east of Target 6-1. It is visually available from a range of 3578 feet. Three 37mm antiaircraft guns are emplaced in revetments separated by 35 meters. Communication trenches connect the three positions. The site is in an open field 15 meters west of a gravel road and 15 meters south of a single railroad track running parallel to a highway. The triangular pattern of guns and the distributed earth of the trenches and revetments are visible against the green field.

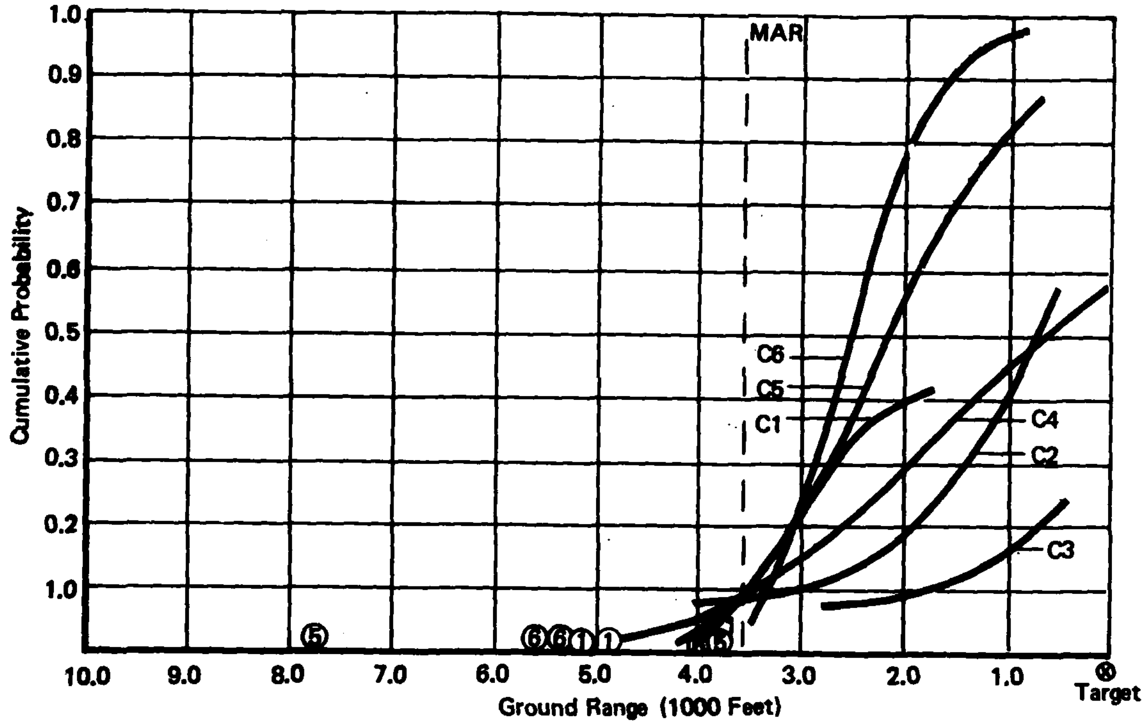


Figure 4-A-22: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions for Target 6-2, Light Anti-Aircraft Battery

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	2683	1073	1607	.700	.500	.167	.167
2	FAC	360	Low	1577	920	1375	.743	.583	.167	.0
3	None	360	Low	1507	377	1214	.895	.250	.083	.0
4	None	220	Low	1790	1044	1502	.708	.583	.250	.0
5	None	360	High	2134	1921	2571	.463	.917	.167	.167
6	None	220	High	2302	2302	2610	.357	1.0	.083	.250
All Conditions				2020	1212	1760	.661	.639	.153	.097

MISSION 6, TARGET 3

Target 6-3 is a tank convoy located 3.4 nautical miles southeast of Target 6-2. It is visually available from a range of 13,126 feet. Four medium tanks and a medium recovery vehicle are parked on the south shoulder of a highway, between the road and a parallel railroad track. Separation between vehicles is 100 meters. The vehicles are painted olive drab and are visible against the earth road shoulder.

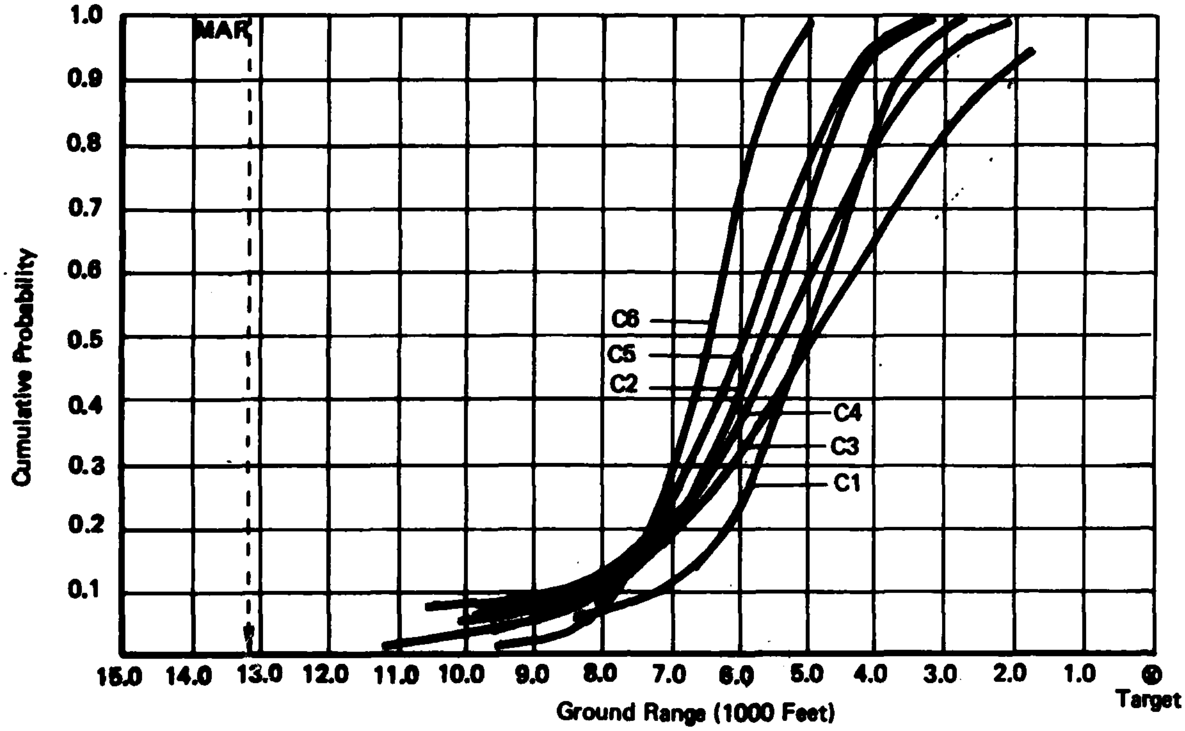
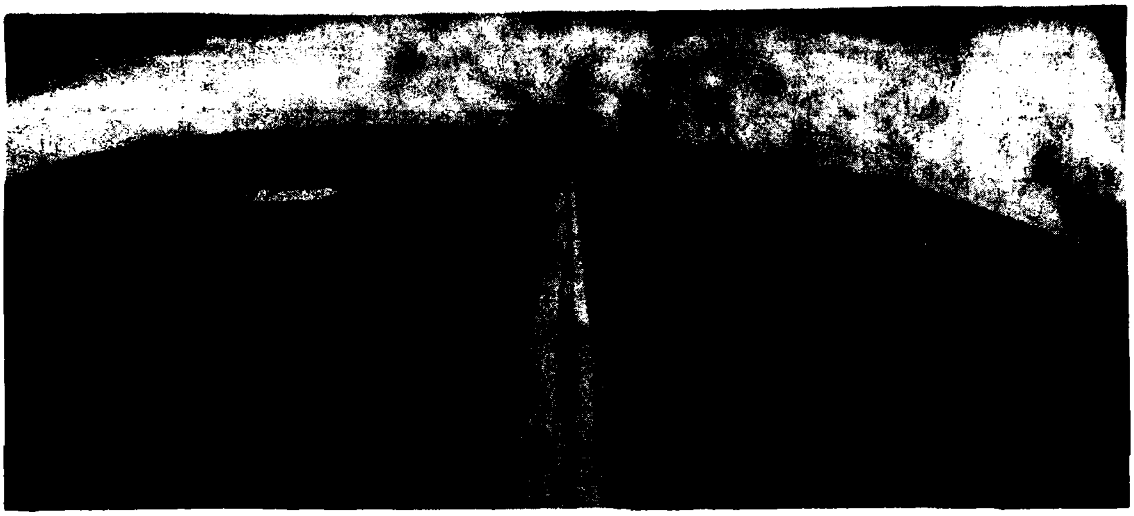


Figure 4-A-23: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions for Target 6-3, Tank Convoy

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	5059	5059	5623	.615	1.0	.0	.0
2	FAC	360	Low	6069	6069	6665	.538	1.0	.083	.0
3	None	360	Low	4988	4573	4949	.652	.917	.0	.0
4	None	220	Low	5828	5828	5755	.556	1.0	.0	.0
5	None	360	High	5361	5361	6015	.592	1.0	.0	.0
6	None	220	High	6656	6656	6914	.493	1.0	.0	.0
All Conditions				5670	5591	5975	.574	.986	.014	.0



MISSION 6, TARGET 4

Target 6-4 is a vehicle park located 1.9 nautical miles southeast of Target 6-3. It is visually available from a range of 7375 feet. The target consists of the following elements: seven 2½ ton trucks, three of which are towing 122mm howitzers; three armored personnel carriers, each towing a 122mm howitzer; and two medium tanks. All units are painted olive drab and they are haphazardly parked in an area 100 meters square. The target area is in an empty green field and heavy vehicle tracks are clearly visible.

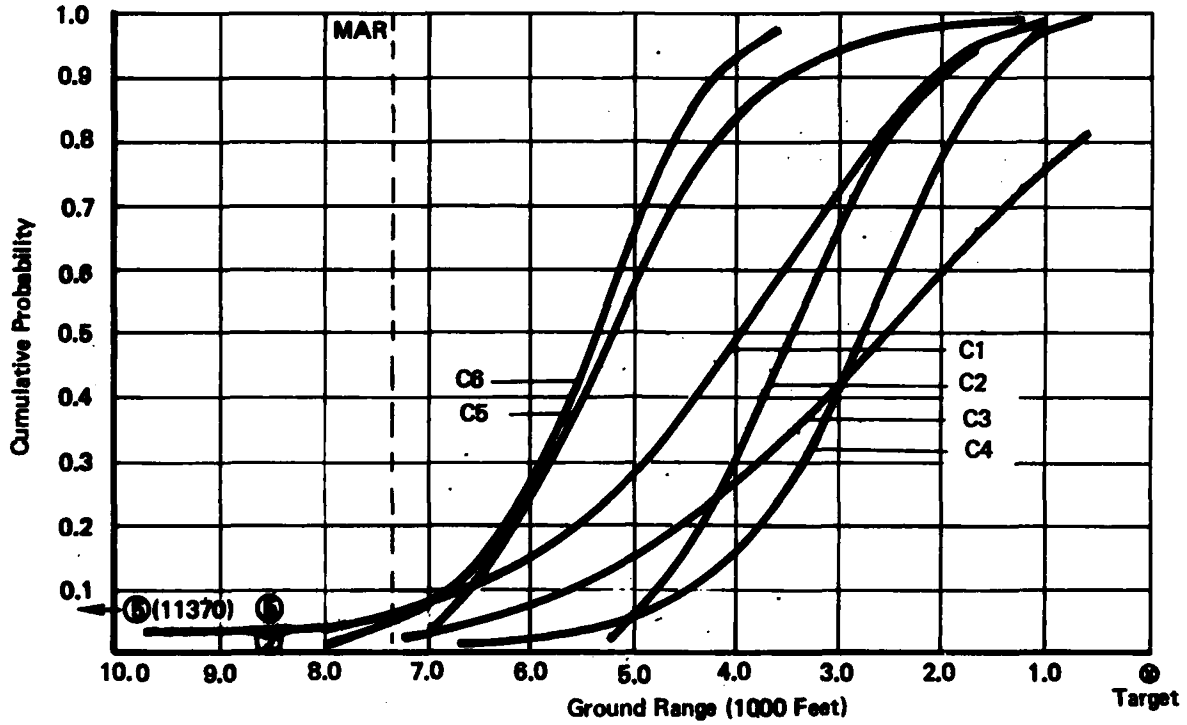


Figure 4-A-24: Target Acquisition Probability as a Function of Ground Range, Shown by Conditions for Target 6-4, Vehicle Park

CONDITION	VARIABLE LEVEL			DATA SUMMARY						
	Cueing	Speed	Briefing	Means of Acquisition Only	Obtained Wtd Mean Acq Range	Predicted Wtd Mean Acq Range	SPR	p (Correct)	p (Incorrect)	p (Premature)
1	Range to Go	360	Low	4065	3726	3647	.495	.917	.0	.0
2	FAC	360	Low	3207	3207	3399	.565	1.0	.0	.083
3	None	360	Low	2891	2409	2598	.674	.833	.0	.0
4	None	220	Low	2606	2606	2885	.647	1.0	.0	.0
5	None	360	High	4737	4737	4754	.358	1.0	.0	.167
6	None	220	High	5198	5198	5069	.295	1.0	.083	.0
All Conditions				3787	3622	3684	.509	.958	.014	.042

APPENDIX 5

ANNEX A

TARGET CATALOGING INFORMATION

The process of preparing the 70mm color imagery for systematic use in simulation studies was begun in 1967 after completion of filming at the JTF-2 Test 4.4 field test site (Reference 1). The process was expanded to meet the SEEKVAL IA2 requirements.

This process includes a number of steps dealing with positive identification of individual film rolls, correlation of dynamic imagery with ground-truth reference photography, selection and integration of rolls into full simulator mission films, and detailed frame-by-frame cataloging of track coverage and target content.

Initially, reference photography (vertical and oblique) was prepared as a ground-truth reference for the JTF-2 4.4 test courses against which the dynamic 70mm coverage could be compared. These photomaps are complemented by transparent overlays that identify all targets, checkpoints, and principal terrain features. Course centerlines are also shown for comparison with ground tracks made good during dynamic filming.

The 70mm JTF-2 4.4 dynamic imagery was then evaluated and positively identified on a roll-by-roll basis, selecting those rolls required to provide integrated, continuous simulator missions representing specified coverages of the North and South courses. A master copy of each mission film was then integrated and spliced with the selection of particular splice points within the overlap of contiguous rolls based on the "best match" with regard to ground track and aircraft attitude. Cue marks indicating these splice points were then introduced on the negatives to insure identical splicing of all subsequent prints.

Subsequently, the suitability of the imagery for simulation usage and target locations within the imagery were determined.

Cataloging of target content and availability for each target in each full-mission film was accomplished using the projector described in Section A.3.b.(4).(a). The procedure required frame-by-frame viewing and cumulative frame counting while operating the projector in both forward and reverse directions through each target encounter occurring in the complete film. Cataloging is recorded on the basis of cumulative frame number relative to an index frame at the beginning of each full-mission film.

Using the SEEKVAL IA2 test design in conjunction with the available JTF-2 4.4 imagery information, the imagery preparation tasks for the current project were to select targets, derive appropriate missions, and calculate mission-event range/time data. The tables contained in this appendix summarize the results of these tasks.

The selection of 24 of the 49 available targets and the distribution of these over 6 missions were based on the following set of simultaneous requirements:

- Six missions were required of approximately equal length; each had to contain an IP and four targets.

- Inter-target intervals had to be of sufficient length that each target encounter could be considered independent of the preceding and subsequent ones.

- Selected targets had to represent as broad a spectrum as possible of small tactical targets.

- The IPs had to be prominent and difficult to miss or confuse.

- The targets and IPs had to be clearly visible, and close enough to the flight-path centerline to pass off the bottom of the projection screen rather than the sides.

- As much as possible, the targets and IPs had to be clearly shown in the vertical and forward oblique briefing photography.

After these requirements had been met, one set of dynamic imagery prints was cut and spliced as appropriate for the Dynamic Imagery Experiment. In addition, single frames were excised from another set of prints and mounted as slides for the static imagery studies and physical target/background measures.

TABLE 5-A-1 SEEKVAL IA2 TARGET LOCATION AND AVAILABILITY DATA

MISSIONS 1, 2, and 3

JTF-2 Film: North Target-to-Target - 300'

Target Name	Target Number	First Available	Last in FOV	Nadir/Abeam
			Cumulative Frame Numbers	
		MISSION 1		
Orange Marker	IP-1	5,346	6,064	6,080
Med AAA Battery	1-1	9,750	10,043	10,057
Self-Propelled Howitzer Batry.	1-2	11,609	11,853	11,867
Pontoon Bridge	1-3	14,301	14,523	14,537
Towed Howitzers	1-4	15,056	15,374	15,382
		End Frame: 15,499		
		MISSION 2		
Dirt Airstrip	IP-2	1,810	2,385* 2,448	2,452
Vehicle Park	2-1	3,630	3,965	3,981
POL Site	2-2	10,285	10,441	10,457
Heavy How-itzer Battery	2-3	11,991	12,468	12,484
Helicopter Pad	2-4	13,673	13,898	13,914
		End Frame: 14,099 *I.P. over end of runway		
		MISSION 3		
Storage Area	IP-3	1,316	1,494	1,510
Tank Platoon	3-1	2,426	2,786	2,802
Antitank Battery	3-2	3,589	3,987	4,001
FROG Site	3-3	5,011	5,225	5,239
SAM Site	3-4	9,463	9,704	9,710
		End Frame: 11,343		

TABLE 5-A-2 SEEKVAL IA2 TARGET LOCATION AND AVAILABILITY DATA

MISSIONS 4, 5 and 6

JTF-2 4.4 Film: South-Route-300'

Target Name	Target Number	First Available	Cumulative Frame Numbers: Last in FOV	Nadir/Abeam
		MISSION 4		
Watertower	IP-4	497	1,137	1,152
Tank Convoy	4-1	3,171	3,475	3,489
Vehicle Park	4-2	3,992	4,198	4,211
SAM Site	4-3	6,164	6,589	6,603
AA Machine Guns	4-4	10,762	10,955	10,969
		End Frame: 11,099		
		MISSION 5		
"Y" Road Junction	IP-5	825	960	974
Medium AA Battery	5-1	1,170	1,390	1,403
SAM Convoy	5-2	1,847	2,157	2,171
Truck Convoy	5-3	7,335	7,714	7,728
Heavy AA Machine Gun Battery	5-4	11,352	11,504	11,518
		End Frame: 11,937		
		MISSION 6		
Blue Roofed School House	IP-6	4,183	4,597	4,611
SAM Convoy	6-1	6,955	7,194	7,208
Lt. AA Battery	6-2	9,028	9,177	9,191
Tank Convoy	6-3	9,574	10,158	10,172
Vehicle Park	6-4	10,364	10,686	10,700
		End Frame: 12,856		

TABLE 5-A-3

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 1

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-1	5,964	116,954	19.25	5 + 15	3 + 12
IP-1	1-1	3,979	78,028	12.84	3 + 30	2 + 08
1-1	1-2	1,810	35,494	5.84	1 + 36	0 + 58
1-2	1-3	2,670	52,359	8.61	2 + 21	1 + 26
1-3	1-4	851	16,688	2.75	0 + 45	0 + 27
*Start	1-4	15,374	301,484	49.62	13 + 32	8 + 16

19.61 Ground Feet/Frame of Film

Projection Rate: 18.94 Frames/Sec. (220 Kts)

30.99 Frames/Sec. (360 Kts)

*Based on the inclusion of 100 frames of film leader

TABLE 5-A-4

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 2

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-2	2,285	44,763	7.36	2 + 01	1 + 14
IP-2	2-1	1,580	30,952	5.09	1 + 23	0 + 51
2-1	2-2	6,476	126,865	20.88	5 + 42	3 + 29
2-2	2-3	2,027	39,709	6.54	1 + 47	1 + 05
2-3	2-4	1,430	28,013	4.61	1 + 15	0 + 46
*Start	2-4	13,898	272,262	44.81	12 + 13	7 + 28

19.59 Ground Feet/Frame of Film

Projection Rate: 18.96 Frames/Sec. (220 Kts)

31.02 Frames/Sec. (360 Kts)

TABLE 5-A-5

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 3

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-3	1,390	26,174	4.31	1 + 10	0 + 43
IP-3	3-1	1,296	24,404	4.02	1 + 06	0 + 40
3-1	3-2	1,201	22,615	3.72	1 + 01	0 + 37
3-2	3-3	1,238	23,312	3.84	1 + 03	0 + 38
3-3	3-4	4,479	84,340	13.88	3 + 47	2 + 19
*Start	3-4	9,704	182,726	30.07	8 + 12	5 + 01

18.83 Ground Feet/Frame of Film

Projection: 19.72 Frames/Sec. (220 Kts)

32.27 Frames/Sec. (360 Kts)

TABLE 5-A-6

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 4

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-4	1,037	21,476	3.53	0 + 58	0 + 35
IP-4	4-1	2,338	48,420	7.97	2 + 10	1 + 20
4-1	4-2	723	14,973	2.46	0 + 40	0 + 25
4-2	4-3	2,391	49,518	8.15	2 + 13	1 + 21
4-3	4-4	4,366	90,420	14.88	4 + 04	2 + 29
*Start	4-4	10,955	226,878	37.34	10 + 11	6 + 13

20.71 Ground Feet/Frame of Film

Projection Rate: 17.93 Frames/Sec. (220 Kts)

29.34 Frames/Sec. (360 Kts)

TABLE 5-A-7

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 5

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-5	860	18,627	3.06	0 + 50	0 + 30
IP-5	5-1	430	9,314	1.53	0 + 25	0 + 15
5-1	5-2	767	16,613	2.73	0 + 45	0 + 27
5-2	5-3	5,557	120,364	19.80	5 + 24	3 + 18
5-3	5-4	3,790	82,091	13.51	3 + 41	2 + 15
*Start	5-4	11,504	249,177	41.01	11 + 11	6 + 50

21.66 Ground Feet/Frame of Film

Projection Rate: 17.14 Frames/Sec. (220 Kts)

28.06 Frames/Sec. (360 Kts)

TABLE 5-A-8

FRAME - DISTANCE - TIME

TARGET TO TARGET

MISSION 6

From	To	Frames	Distance (Feet)	Distance (NM)	Time (220 Kts)	Time (360 Kts)
Start	IP-6	4,497	98,709	16.24	4 + 26	2 + 42
IP-6	6-1	2,597	57,004	9.38	2 + 34	1 + 34
6-1	6-2	1,983	43,527	7.16	1 + 57	1 + 12
6-2	6-3	981	21,532	3.54	0 + 58	0 + 35
6-3	6-4	528	11,590	1.91	0 + 31	0 + 19
*Start	6-4	10,686	234,558	38.60	10 + 32	6 + 26

21.95 Ground Feet/Frame of Film

Projection Rate: 16.92 Frames/Sec. (220 Kts)

27.68 Frames/Sec. (360 Kts)

TABLE 5-A-9 TARGET VISUAL AVAILABILITY RANGE AND TIME

Target	Frames in FOV	Distance in FOV*	NM	Time in FOV (Min. + Sec.) 220 Kts	360 Kts
IP-1	718	14,080	2.32	0 + 38	0 + 23
1-1	293	5,746	0.94	0 + 15	0 + 09
1-2	244	4,785	0.79	0 + 13	0 + 08
1-3	222	4,353	0.72	0 + 12	0 + 07
1-4	318	6,236	1.03	0 + 17	0 + 10
IP-2	575	11,264	1.85	0 + 30	0 + 18
2-1	335	6,563	1.08	0 + 18	0 + 11
2-2	156	3,056	0.50	0 + 08	0 + 05
2-3	477	9,344	1.54	0 + 25	0 + 15
2-4	225	4,408	0.72	0 + 12	0 + 07
IP-3	174	3,276	0.53	0 + 09	0 + 05
3-1	360	6,779	1.12	0 + 18	0 + 11
3-2	398	7,494	1.23	0 + 20	0 + 12
3-3	214	4,030	0.66	0 + 11	0 + 07
3-4	241	4,538	0.75	0 + 12	0 + 07
IP-4	640	13,254	2.18	0 + 36	0 + 22
4-1	304	6,296	1.04	0 + 17	0 + 10
4-2	206	4,266	0.70	0 + 11	0 + 07
4-3	425	8,802	1.45	0 + 24	0 + 14
4-4	193	3,997	0.66	0 + 11	0 + 06
IP-5	135	2,924	0.48	0 + 08	0 + 05
5-1	220	4,765	0.78	13	0 + 08
5-2	310	6,715	1.10	0 + 18	0 + 11
5-3	379	8,209	1.35	0 + 22	0 + 14
5-4	152	3,292	0.54	0 + 09	0 + 05
IP-6	414	9,087	1.50	0 + 24	0 + 15
6-1	239	5,246	0.86	0 + 14	0 + 09
6-2	149	3,270	0.54	0 + 09	0 + 05
6-3	584	12,819	2.11	0 + 34	0 + 21
6-4	322	7,068	1.16	0 + 19	0 + 12

*Note: These are not the same as MAR since MAR is computed to the target nadir/abeam position of the simulated aircraft. See Sect. A.3.f(2) for details.

FOV = Field of View

APPENDIX 6

ANNEX A

DYNAMIC IMAGERY EXPERIMENT-RAW DATA

The pages that follow contain raw data for each of the 1728 trials of the Dynamic Imagery Experiment. Each line represents one trial. Trials are ordered by subject, conditions and target. Column contents and the meaning of their entries are noted below:

SUB: Subject number 1 to 72

CON: Condition number 1 to 6
- 1-Range to go, 360Kts, Low Briefing
- 2-FAC, 360Kts, Low Briefing
- 3-No Cueing, 360Kts, Low Briefing
- 4-No Cueing, 220Kts, Low Briefing
- 5-No Cueing, 360Kts, High Briefing
- 6-No Cueing, 220Kts, High Briefing

BRE: Briefing level
- 1-Low
- 2-High

SPE: Speed
- 1-220 Knots
- 2-360 Knots

CUE: Cueing condition
- 1-No cueing
- 2-FAC
- 3-Range-to-go

FLY: Flight; position in the sequence of six flights taken by this subject

MIS: Mission; which of the six different target sets this subject saw under this condition

TAR: Target; which of the four targets in this mission this subject was attempting to acquire

RES: Result of this trial
- 0-Subject missed the target
- 1-Subject acquired the target
- 5-Subject "acquired" the target before maximum available range

RANGE: Acquisition range in feet

SPR: Search Performance Ratio as defined in the text

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
1	1	1	2	3	3	4	1	0	0	1.000
1	1	1	2	3	3	4	2	0	0	1.000
1	1	1	2	3	3	4	3	1	1678	.815
1	1	1	2	3	3	4	4	0	0	1.000
1	2	1	2	2	5	5	1	1	2816	.442
1	2	1	2	2	5	5	2	1	3401	.518
1	2	1	2	2	5	5	3	1	5913	.305
1	2	1	2	2	5	5	4	1	1668	.536
1	3	1	2	1	4	1	1	1	1981	.671
1	3	1	2	1	4	1	2	1	3628	.283
1	3	1	2	1	4	1	3	0	0	1.000
1	3	1	2	1	4	1	4	1	3471	.457
1	4	1	1	1	2	3	1	1	3371	.524
1	4	1	1	1	2	3	2	1	4595	.408
1	4	1	1	1	2	3	3	1	2034	.526
1	4	1	1	1	2	3	4	1	2071	.555
1	5	2	2	1	1	2	1	1	313	.954
1	5	2	2	1	1	2	2	0	0	1.000
1	5	2	2	1	1	2	3	1	1622	.811
1	5	2	2	1	1	2	4	1	2625	.444
1	6	2	1	1	6	6	1	1	4412	.206
1	6	2	1	1	6	6	2	1	1251	.650
1	6	2	1	1	6	6	3	1	6914	.473
1	6	2	1	1	6	6	4	1	4741	.357
2	1	1	2	3	5	4	1	1	3417	.431
2	1	1	2	3	5	4	2	1	1098	.758
2	1	1	2	3	5	4	3	1	3311	.581
2	1	1	2	3	5	4	4	0	0	1.000
2	2	1	2	2	4	2	1	1	2077	.698
2	2	1	2	2	4	2	2	1	979	.739
2	2	1	2	2	4	2	3	1	1661	.607
2	2	1	2	2	4	2	4	1	1450	.693
2	3	1	2	1	1	3	1	1	3728	.473
2	3	1	2	1	1	3	2	1	1627	.765
2	3	1	2	1	1	3	3	1	1027	.575
2	3	1	2	1	1	3	4	1	2662	.385
2	4	1	1	1	6	6	1	1	3336	.399
2	4	1	1	1	6	6	2	1	1185	.669
2	4	1	1	1	6	6	3	1	5926	.548
2	4	1	1	1	6	6	4	1	2546	.655
2	5	2	2	1	2	5	1	1	1949	.614
2	5	2	2	1	2	5	2	1	5935	.160
2	5	2	2	1	2	5	3	1	4245	.501
2	5	2	2	1	2	5	4	1	1061	.705
2	6	2	1	1	3	1	1	1	2549	.577
2	6	2	1	1	3	1	2	1	2608	.484
2	6	2	1	1	3	1	3	1	2471	.466
2	6	2	1	1	3	1	4	1	2981	.534

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
3	1	1	2	3	5	1	1	1	4902	.186
3	1	1	2	3	5	1	2	1	3294	.349
3	1	1	2	3	5	1	3	5	4863	-.051
3	1	1	2	3	5	1	4	1	4197	.344
3	2	1	2	2	6	4	1	0	0	1.000
3	2	1	2	2	6	4	2	0	0	1.000
3	2	1	2	2	6	4	3	1	3583	.606
3	2	1	2	2	6	4	4	1	891	.792
3	3	1	2	1	4	5	1	5	7278	-.442
3	3	1	2	1	4	5	2	5	7928	-.123
3	3	1	2	1	4	5	3	1	7299	.142
3	3	1	2	1	4	5	4	1	477	.867
3	4	1	1	1	3	3	1	1	3785	.465
3	4	1	1	1	3	3	2	1	4237	.454
3	4	1	1	1	3	3	3	1	2504	.417
3	4	1	1	1	3	3	4	1	3333	.283
3	5	2	2	1	2	6	1	5	7792	-.403
3	5	2	2	1	2	6	2	1	1361	.620
3	5	2	2	1	2	6	3	1	2041	.644
3	5	2	2	1	2	6	4	5	8517	-.155
3	6	2	1	1	1	2	1	1	5328	.225
3	6	2	1	1	1	2	2	1	2135	.366
3	6	2	1	1	1	2	3	1	3311	.657
3	6	2	1	1	1	2	4	1	3742	.207
4	1	1	2	3	2	6	1	1	3249	.415
4	1	1	2	3	2	6	2	0	0	1.000
4	1	1	2	3	2	6	3	1	4939	.624
4	1	1	2	3	2	6	4	1	4302	.417
4	2	1	2	2	5	4	1	1	3314	.497
4	2	1	2	2	5	4	2	0	0	1.000
4	2	1	2	2	5	4	3	1	7973	.123
4	2	1	2	2	5	4	4	1	787	.816
4	3	1	2	1	4	2	1	1	3800	.447
4	3	1	2	1	4	2	2	1	1900	.436
4	3	1	2	1	4	2	3	1	2155	.777
4	3	1	2	1	4	2	4	0	0	1.000
4	4	1	1	1	3	5	1	1	2426	.519
4	4	1	1	1	3	5	2	1	4895	.307
4	4	1	1	1	3	5	3	1	2837	.667
4	4	1	1	1	3	5	4	1	2339	.349
4	5	2	2	1	6	1	1	1	2785	.537
4	5	2	2	1	6	1	2	1	4314	.147
4	5	2	2	1	6	1	3	1	2216	.521
4	5	2	2	1	6	1	4	1	3079	.518
4	6	2	1	1	1	3	1	1	3898	.449
4	6	2	1	1	1	3	2	1	5856	.245
4	6	2	1	1	1	3	3	1	2768	.355
4	6	2	1	1	1	3	4	1	3145	.324

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
5	1	1	2	3	5	2	1	1	3350	.513
5	1	1	2	3	5	2	2	1	1587	.529
5	1	1	2	3	5	2	3	1	3644	.623
5	1	1	2	3	5	2	4	1	2762	.415
5	2	1	2	2	4	5	1	1	1906	.622
5	2	1	2	2	4	5	2	1	4549	.356
5	2	1	2	2	4	5	3	1	4289	.496
5	2	1	2	2	4	5	4	1	477	.807
5	3	1	2	1	3	6	1	1	2393	.569
5	3	1	2	1	3	6	2	0	0	1.000
5	3	1	2	1	3	6	3	1	4097	.642
5	3	1	2	1	3	6	4	1	3556	.518
5	4	1	1	1	6	1	1	1	5295	.121
5	4	1	1	1	6	1	2	1	3961	.217
5	4	1	1	1	6	1	3	1	2353	.492
5	4	1	1	1	6	1	4	1	4628	.276
5	5	2	2	1	1	4	1	1	3334	.494
5	5	2	2	1	1	4	2	1	2195	.516
5	5	2	2	1	1	4	3	0	0	1.000
5	5	2	2	1	1	4	4	1	1388	.676
5	6	2	1	1	2	3	1	1	3691	.479
5	6	2	1	1	2	3	2	1	2636	.660
5	6	2	1	1	2	3	3	1	1921	.553
5	6	2	1	1	2	3	4	1	2071	.555
6	1	1	2	3	2	3	1	1	2624	.601
6	1	1	2	3	2	3	2	1	3163	.592
6	1	1	2	3	2	3	3	1	1921	.553
6	1	1	2	3	2	3	4	1	2763	.405
6	2	1	2	2	6	6	1	1	3622	.348
6	2	1	2	2	6	6	2	0	0	1.000
6	2	1	2	2	6	6	3	1	5575	.575
6	2	1	2	2	6	6	4	1	1471	.801
6	3	1	2	1	3	5	1	1	1863	.631
6	3	1	2	1	3	5	2	1	3617	.488
6	3	1	2	1	3	5	3	1	6043	.290
6	3	1	2	1	3	5	4	1	563	.843
6	4	1	1	1	1	1	1	1	1726	.713
6	4	1	1	1	1	1	2	1	2314	.543
6	4	1	1	1	1	1	3	1	1726	.627
6	4	1	1	1	1	1	4	1	2059	.678
6	5	2	2	1	4	2	1	1	4682	.319
6	5	2	2	1	4	2	2	1	2018	.401
6	5	2	2	1	4	2	3	1	1998	.793
6	5	2	2	1	4	2	4	1	2880	.390
6	6	2	1	1	5	4	1	1	3376	.487
6	6	2	1	1	5	4	2	1	1698	.626
6	6	2	1	1	5	4	3	1	4535	.501
6	6	2	1	1	5	4	4	1	1802	.580

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
7	1	1	2	3	3	6	1	5	6102	-.099
7	1	1	2	3	3	6	2	5	4873	-.362
7	1	1	2	3	3	6	3	1	5466	.584
7	1	1	2	3	3	6	4	1	4127	.440
7	2	1	2	2	5	3	1	1	5762	.186
7	2	1	2	2	5	3	2	5	7890	-.017
7	2	1	2	2	5	3	3	0	0	1.000
7	2	1	2	2	5	3	4	5	4915	-.057
7	3	1	2	1	4	4	1	5	13586	-1.063
7	3	1	2	1	4	4	2	5	5302	-.169
7	3	1	2	1	4	4	3	1	2899	.681
7	3	1	2	1	4	4	4	5	8222	-.918
7	4	1	1	1	2	2	1	1	2351	.658
7	4	1	1	1	2	2	2	1	1508	.552
7	4	1	1	1	2	2	3	1	20	.998
7	4	1	1	1	2	2	4	1	862	.817
7	5	2	2	1	1	1	1	1	2589	.570
7	5	2	2	1	1	1	2	1	3608	.287
7	5	2	2	1	1	1	3	1	4020	.131
7	5	2	2	1	1	1	4	1	4412	.310
7	6	2	1	1	6	5	1	1	4072	.193
7	6	2	1	1	6	5	2	1	2448	.653
7	6	2	1	1	6	5	3	1	3401	.601
7	6	2	1	1	6	5	4	1	3076	.145
8	1	1	2	3	6	4	1	1	3148	.522
8	1	1	2	3	6	4	2	1	1802	.603
8	1	1	2	3	6	4	3	1	2506	.724
8	1	1	2	3	6	4	4	1	2092	.512
8	2	1	2	2	3	5	1	1	3292	.348
8	2	1	2	2	3	5	2	1	3790	.463
8	2	1	2	2	3	5	3	1	4635	.455
8	2	1	2	2	3	5	4	1	1928	.464
8	3	1	2	1	5	6	1	0	0	1.000
8	3	1	2	1	5	6	2	0	0	1.000
8	3	1	2	1	5	6	3	1	1668	.873
8	3	1	2	1	5	6	4	1	1910	.741
8	4	1	1	1	4	2	1	1	1469	.786
8	4	1	1	1	4	2	2	1	1587	.529
8	4	1	1	1	4	2	3	0	0	1.000
8	4	1	1	1	4	2	4	0	0	1.000
8	5	2	2	1	2	3	1	1	3540	.500
8	5	2	2	1	2	3	2	1	2147	.723
8	5	2	2	1	2	3	3	1	1412	.671
8	5	2	2	1	2	3	4	1	3333	.283
8	6	2	1	1	1	1	1	1	2667	.557
8	6	2	1	1	1	1	2	1	2706	.465
8	6	2	1	1	1	1	3	1	2902	.373
8	6	2	1	1	1	1	4	1	3353	.475

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
9	1	1	2	3	6	5	1	0	0	1.000
9	1	1	2	3	6	5	2	1	4787	.322
9	1	1	2	3	6	5	3	1	3466	.593
9	1	1	2	3	6	5	4	1	758	.739
9	2	1	2	2	1	4	1	1	3106	.526
9	2	1	2	2	1	4	2	1	1180	.740
9	2	1	2	2	1	4	3	1	849	.907
9	2	1	2	2	1	4	4	1	1118	.739
9	3	1	2	1	2	6	1	1	2788	.498
9	3	1	2	1	2	6	2	0	0	1.000
9	3	1	2	1	2	6	3	1	5466	.584
9	3	1	2	1	2	6	4	1	4170	.435
9	4	1	1	1	3	1	1	0	0	1.000
9	4	1	1	1	3	1	2	1	3255	.357
9	4	1	1	1	3	1	3	1	510	.890
9	4	1	1	1	3	1	4	1	4020	.371
9	5	2	2	1	5	3	1	1	4802	.322
9	5	2	2	1	5	3	2	1	3879	.500
9	5	2	2	1	5	3	3	1	2580	.399
9	5	2	2	1	5	3	4	1	3502	.247
9	6	2	1	1	4	2	1	1	4369	.365
9	6	2	1	1	4	2	2	1	2292	.320
9	6	2	1	1	4	2	3	0	0	1.000
9	6	2	1	1	4	2	4	1	3698	.174
10	1	1	2	3	2	2	1	1	3056	.556
10	1	1	2	3	2	2	2	1	764	.773
10	1	1	2	3	2	2	3	1	2508	.740
10	1	1	2	3	2	2	4	1	3174	.328
10	2	1	2	2	1	1	1	1	4197	.303
10	2	1	2	2	1	1	2	1	2118	.581
10	2	1	2	2	1	1	3	1	2824	.390
10	2	1	2	2	1	1	4	1	4353	.319
10	3	1	2	1	6	5	1	5	5892	-.167
10	3	1	2	1	6	5	2	5	7624	-.080
10	3	1	2	1	6	5	3	1	7061	.170
10	3	1	2	1	6	5	4	5	7278	-1.024
10	4	1	1	1	5	6	1	1	3402	.387
10	4	1	1	1	5	6	2	1	3183	.110
10	4	1	1	1	5	6	3	1	6146	.532
10	4	1	1	1	5	6	4	1	2458	.667
10	5	2	2	1	4	3	1	1	5385	.239
10	5	2	2	1	4	3	2	1	6459	.167
10	5	2	2	1	4	3	3	1	885	.794
10	5	2	2	1	4	3	4	1	2429	.478
10	6	2	1	1	3	4	1	1	5757	.126
10	6	2	1	1	3	4	2	1	2195	.516
10	6	2	1	1	3	4	3	1	3686	.595
10	6	2	1	1	3	4	4	1	3376	.213

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
11	1	1	2	3	1	1	1	1	1353	.775
11	1	1	2	3	1	1	2	1	2490	.508
11	1	1	2	3	1	1	3	1	1883	.593
11	1	1	2	3	1	1	4	1	2451	.617
11	2	1	2	2	4	6	1	1	4258	.233
11	2	1	2	2	4	6	2	0	0	1.000
11	2	1	2	2	4	6	3	1	5422	.587
11	2	1	2	2	4	5	4	1	2678	.637
11	3	1	2	1	5	4	1	1	3500	.469
11	3	1	2	1	5	4	2	1	2589	.429
11	3	1	2	1	5	4	3	1	5115	.437
11	3	1	2	1	5	4	4	1	2713	.307
11	4	1	1	1	6	5	1	1	2253	.554
11	4	1	1	1	6	5	2	1	4895	.307
11	4	1	1	1	6	5	3	1	4722	.445
11	4	1	1	1	6	5	4	5	4895	-.361
11	5	2	2	1	2	2	1	1	4858	.293
11	5	2	2	1	2	2	2	0	0	1.000
11	5	2	2	1	2	2	3	1	3252	.663
11	5	2	2	1	2	2	4	1	3213	.320
11	6	2	1	1	3	3	1	1	5385	.239
11	6	2	1	1	3	3	2	1	6647	.143
11	6	2	1	1	3	3	3	1	3672	.145
11	6	2	1	1	3	3	4	1	3163	.320
12	1	1	2	3	6	1	1	1	1294	.785
12	1	1	2	3	6	1	2	1	2569	.492
12	1	1	2	3	6	1	3	1	2137	.538
12	1	1	2	3	6	1	4	1	2843	.555
12	2	1	2	2	1	6	1	1	3227	.419
12	2	1	2	2	1	6	2	0	0	1.000
12	2	1	2	2	1	6	3	1	3227	.754
12	2	1	2	2	1	5	4	1	4192	.432
12	3	1	2	1	5	2	1	1	2135	.689
12	3	1	2	1	5	2	2	1	1273	.622
12	3	1	2	1	5	2	3	1	1293	.866
12	3	1	2	1	5	2	4	0	0	1.000
12	4	1	1	1	4	5	1	1	1170	.768
12	4	1	1	1	4	5	2	1	3790	.463
12	4	1	1	1	4	5	3	1	4397	.483
12	4	1	1	1	4	5	4	1	888	.753
12	5	2	2	1	3	3	1	1	5423	.234
12	5	2	2	1	3	3	2	5	9170	-.182
12	5	2	2	1	3	3	3	1	2203	.487
12	5	2	2	1	3	3	4	1	2862	.385
12	6	2	1	1	2	4	1	1	5302	.195
12	6	2	1	1	2	4	2	1	1450	.680
12	6	2	1	1	2	4	3	1	3583	.606
12	6	2	1	1	2	4	4	1	21	.995

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
13	1	1	2	3	3	5	1	1	1300	.742
13	1	1	2	3	3	5	2	1	3726	.472
13	1	1	2	3	3	5	3	0	0	1.000
13	1	1	2	3	3	5	4	1	715	.801
13	2	1	2	2	1	3	1	1	3314	.532
13	2	1	2	2	1	3	2	1	6515	.160
13	2	1	2	2	1	3	3	0	0	1.000
13	2	1	2	2	1	3	4	1	2561	.449
13	3	1	2	1	6	2	1	1	2116	.692
13	3	1	2	1	6	2	2	1	1646	.512
13	3	1	2	1	6	2	3	1	3859	.600
13	3	1	2	1	6	2	4	0	0	1.000
13	4	1	1	1	2	4	1	5	9216	-.399
13	4	1	1	1	2	4	2	0	0	1.000
13	4	1	1	1	2	4	3	1	3500	.615
13	4	1	1	1	2	4	4	0	0	1.000
13	5	2	2	1	5	6	1	1	5246	.055
13	5	2	2	1	5	6	2	1	3227	.098
13	5	2	2	1	5	6	3	1	10558	.196
13	5	2	2	1	5	6	4	1	4785	.351
13	6	2	1	1	4	1	1	1	1726	.713
13	6	2	1	1	4	1	2	5	8334	-.647
13	6	2	1	1	4	1	3	1	1569	.661
13	6	2	1	1	4	1	4	1	3196	.500
14	1	1	2	3	5	5	1	1	2339	.536
14	1	1	2	3	5	5	2	1	4462	.368
14	1	1	2	3	5	5	3	1	5480	.356
14	1	1	2	3	5	5	4	1	1711	.524
14	2	1	2	2	4	4	1	5	9796	-.487
14	2	1	2	2	4	4	2	0	0	1.000
14	2	1	2	2	4	4	3	1	7746	.148
14	2	1	2	2	4	4	4	1	911	.787
14	3	1	2	1	6	3	1	1	3860	.455
14	3	1	2	1	6	3	2	1	5611	.277
14	3	1	2	1	6	3	3	1	3973	.075
14	3	1	2	1	6	3	4	1	3521	.243
14	4	1	1	1	1	6	1	1	3512	.368
14	4	1	1	1	1	6	2	1	22	.994
14	4	1	1	1	1	6	3	1	5861	.554
14	4	1	1	1	1	6	4	1	1975	.732
14	5	2	2	1	3	2	1	1	5799	.157
14	5	2	2	1	3	2	2	1	1939	.424
14	5	2	2	1	3	2	3	1	3840	.602
14	5	2	2	1	3	2	4	1	3389	.282
14	6	2	1	1	2	1	1	1	4863	.192
14	6	2	1	1	2	1	2	1	3608	.237
14	6	2	1	1	2	1	3	1	2706	.415
14	6	2	1	1	2	1	4	1	3942	.383

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
15	1	1	2	3	3	1	1	1	2843	.528
15	1	1	2	3	3	1	2	1	2569	.492
15	1	1	2	3	3	1	3	1	2157	.534
15	1	1	2	3	3	1	4	1	3059	.522
15	2	1	2	2	2	3	1	1	6044	.146
15	2	1	2	2	2	3	2	1	7155	.078
15	2	1	2	2	2	3	3	1	866	.798
15	2	1	2	2	2	3	4	5	6120	-.316
15	3	1	2	1	1	6	1	1	2744	.506
15	3	1	2	1	1	6	2	0	0	1.000
15	3	1	2	1	1	6	3	1	4170	.682
15	3	1	2	1	1	6	4	1	1054	.857
15	4	1	1	1	6	4	1	5	10645	-.616
15	4	1	1	1	6	4	2	1	2154	.525
15	4	1	1	1	6	4	3	1	2982	.672
15	4	1	1	1	6	4	4	1	1201	.720
15	5	2	2	1	4	5	1	1	4873	.034
15	5	2	2	1	4	5	2	5	10288	-.457
15	5	2	2	1	4	5	3	1	3076	.639
15	5	2	2	1	4	5	4	1	2144	.404
15	6	2	1	1	5	2	1	5	14457	-1.103
15	6	2	1	1	5	2	2	5	6112	-.814
15	6	2	1	1	5	2	3	5	10853	-.124
15	6	2	1	1	5	2	4	5	4976	-.054
16	1	1	2	3	4	6	1	1	3644	.344
16	1	1	2	3	4	6	2	1	2678	.252
16	1	1	2	3	4	6	3	1	5070	.614
16	1	1	2	3	4	6	4	1	4083	.446
16	2	1	2	2	2	4	1	1	3189	.516
16	2	1	2	2	2	4	2	1	1698	.626
16	2	1	2	2	2	4	3	1	6006	.339
16	2	1	2	2	2	4	4	0	0	1.000
16	3	1	2	1	3	3	1	1	2429	.657
16	3	1	2	1	3	3	2	1	3389	.563
16	3	1	2	1	3	3	3	1	1638	.618
16	3	1	2	1	3	3	4	1	3597	.227
16	4	1	1	1	1	2	1	1	2938	.573
16	4	1	1	1	1	2	2	1	1293	.616
16	4	1	1	1	1	2	3	1	4114	.574
16	4	1	1	1	1	2	4	0	0	1.000
16	5	2	2	1	5	5	1	5	5090	-.009
16	5	2	2	1	5	5	2	5	7603	-.077
16	5	2	2	1	5	5	3	1	5762	.323
16	5	2	2	1	5	5	4	1	1971	.452
16	6	2	1	1	6	1	1	1	4510	.251
16	6	2	1	1	6	1	2	1	3785	.252
16	6	2	1	1	6	1	3	1	2902	.373
16	6	2	1	1	6	1	4	1	1569	.755

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
17	1	1	2	3	4	2	1	1	3056	.556
17	1	1	2	3	4	2	2	1	1234	.634
17	1	1	2	3	4	2	3	1	1822	.811
17	1	1	2	3	4	2	4	0	0	1.000
17	2	1	2	2	3	6	1	1	3380	.391
17	2	1	2	2	3	6	2	1	2217	.380
17	2	1	2	2	3	6	3	1	7068	.462
17	2	1	2	2	3	6	4	1	2458	.667
17	3	1	2	1	5	5	1	1	606	.880
17	3	1	2	1	5	5	2	1	4310	.390
17	3	1	2	1	5	5	3	1	3531	.585
17	3	1	2	1	5	5	4	1	2491	.307
17	4	1	1	1	6	3	1	1	3747	.471
17	4	1	1	1	6	3	2	1	3163	.592
17	4	1	1	1	6	3	3	1	2730	.364
17	4	1	1	1	6	3	4	1	2712	.417
17	5	2	2	1	2	1	1	1	1824	.697
17	5	2	2	1	2	1	2	1	3216	.364
17	5	2	2	1	2	1	3	1	2902	.373
17	5	2	2	1	2	1	4	1	3314	.482
17	6	2	1	1	1	4	1	1	4287	.349
17	6	2	1	1	1	4	2	1	2299	.493
17	6	2	1	1	1	4	3	1	4411	.515
17	6	2	1	1	1	4	4	1	2278	.469
18	1	1	2	3	1	5	1	0	0	1.000
18	1	1	2	3	1	5	2	0	0	1.000
18	1	1	2	3	1	5	3	1	4549	.466
18	1	1	2	3	1	5	4	1	368	.898
18	2	1	2	2	6	3	1	1	3822	.460
18	2	1	2	2	6	3	2	1	4067	.476
18	2	1	2	2	6	3	3	1	2542	.408
18	2	1	2	2	6	3	4	1	3333	.283
18	3	1	2	1	2	1	1	0	0	1.000
18	3	1	2	1	2	1	2	0	0	1.000
18	3	1	2	1	2	1	3	1	628	.864
18	3	1	2	1	2	1	4	0	0	1.000
18	4	1	1	1	5	4	1	1	3355	.491
18	4	1	1	1	5	4	2	1	2237	.507
18	4	1	1	1	5	4	3	1	2920	.679
18	4	1	1	1	5	4	4	0	0	1.000
18	5	2	2	1	4	6	1	1	4895	.119
18	5	2	2	1	4	6	2	5	3863	-.030
18	5	2	2	1	4	6	3	1	6124	.533
18	5	2	2	1	4	6	4	1	6168	.164
18	6	2	1	1	3	2	1	1	4702	.316
18	6	2	1	1	3	2	2	1	1215	.640
18	6	2	1	1	3	2	3	1	1959	.797
18	6	2	1	1	3	2	4	1	1626	.656

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
19	1	1	2	3	3	2	1	1	4310	.373
19	1	1	2	3	3	2	2	0	0	1.000
19	1	1	2	3	3	2	3	0	0	1.000
19	1	1	2	3	3	2	4	0	0	1.000
19	2	1	2	2	4	1	1	1	5471	.091
19	2	1	2	2	4	1	2	1	2941	.419
19	2	1	2	2	4	1	3	5	6550	-.415
19	2	1	2	2	4	1	4	1	4628	.276
19	3	1	2	1	6	4	1	1	21	.997
19	3	1	2	1	6	4	2	1	2112	.534
19	3	1	2	1	6	4	3	1	4639	.490
19	3	1	2	1	6	4	4	1	83	.981
19	4	1	1	1	5	5	1	1	4570	.094
19	4	1	1	1	5	5	2	1	4527	.359
19	4	1	1	1	5	5	3	1	5047	.407
19	4	1	1	1	5	5	4	1	2231	.380
19	5	2	2	1	1	3	1	1	3239	.543
19	5	2	2	1	1	3	2	5	8699	-.121
19	5	2	2	1	1	3	3	1	3728	.132
19	5	2	2	1	1	3	4	1	3126	.328
19	6	2	1	1	2	6	1	1	4478	.194
19	6	2	1	1	2	6	2	5	5641	-.577
19	6	2	1	1	2	6	3	1	6651	.493
19	6	2	1	1	2	6	4	1	6475	.122
20	1	1	2	3	6	2	1	1	5799	.157
20	1	1	2	3	6	2	2	5	5250	-.558
20	1	1	2	3	6	2	3	1	5799	.400
20	1	1	2	3	6	2	4	1	3663	.224
20	2	1	2	2	2	1	1	1	1883	.687
20	2	1	2	2	2	1	2	5	7001	-.384
20	2	1	2	2	2	1	3	5	5412	-.169
20	2	1	2	2	2	1	4	1	4334	.322
20	3	1	2	1	1	5	1	1	3097	.386
20	3	1	2	1	1	5	2	1	3141	.555
20	3	1	2	1	1	5	3	1	3834	.550
20	3	1	2	1	1	5	4	1	736	.795
20	4	1	1	1	5	3	1	0	0	1.000
20	4	1	1	1	5	3	2	1	3239	.583
20	4	1	1	1	5	3	3	1	3201	.254
20	4	1	1	1	5	3	4	1	4369	.061
20	5	2	2	1	4	4	1	1	2651	.597
20	5	2	2	1	4	4	2	1	2506	.447
20	5	2	2	1	4	4	3	1	3893	.572
20	5	2	2	1	4	4	4	1	2651	.382
20	6	2	1	1	3	6	1	1	3995	.281
20	6	2	1	1	3	6	2	5	5334	-.491
20	6	2	1	1	3	6	3	1	5817	.557
20	6	2	1	1	3	6	4	1	5839	.208

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
21	1	1	2	3	1	3	1	1	3615	.489
21	1	1	2	3	1	3	2	0	0	1.000
21	1	1	2	3	1	3	3	1	998	.768
21	1	1	2	3	1	3	4	1	1167	.749
21	2	1	2	2	2	2	1	1	3193	.536
21	2	1	2	2	2	2	2	0	0	1.000
21	2	1	2	2	2	2	3	1	1371	.858
21	2	1	2	2	2	2	4	0	0	1.000
21	3	1	2	1	6	6	1	1	3458	.375
21	3	1	2	1	6	6	2	1	461	.871
21	3	1	2	1	6	6	3	1	5290	.597
21	3	1	2	1	6	6	4	1	5202	.295
21	4	1	1	1	5	1	1	1	1608	.733
21	4	1	1	1	5	1	2	1	2098	.585
21	4	1	1	1	5	1	3	1	2314	.500
21	4	1	1	1	5	1	4	1	686	.693
21	5	2	2	1	3	5	1	1	2859	.433
21	5	2	2	1	3	5	2	1	4549	.356
21	5	2	2	1	3	5	3	1	5740	.326
21	5	2	2	1	3	5	4	1	1365	.620
21	6	2	1	1	4	4	1	1	3272	.503
21	6	2	1	1	4	4	2	1	870	.808
21	6	2	1	1	4	4	3	1	4038	.556
21	6	2	1	1	4	4	4	1	1325	.691
22	1	1	2	3	5	6	1	1	5334	.040
22	1	1	2	3	5	6	2	5	5180	-.446
22	1	1	2	3	5	6	3	1	5102	.535
22	1	1	2	3	5	6	4	1	4061	.449
22	2	1	2	2	4	3	1	1	6214	.122
22	2	1	2	2	4	3	2	5	8304	-.070
22	2	1	2	2	4	3	3	1	2749	.360
22	2	1	2	2	4	3	4	1	3747	.194
22	3	1	2	1	1	4	1	1	2133	.676
22	3	1	2	1	1	4	2	1	994	.781
22	3	1	2	1	1	4	3	1	4225	.535
22	3	1	2	1	1	4	4	0	0	1.000
22	4	1	1	1	6	2	1	1	4682	.319
22	4	1	1	1	6	2	2	1	1508	.552
22	4	1	1	1	6	2	3	1	4467	.538
22	4	1	1	1	6	2	4	1	4447	.058
22	5	2	2	1	3	1	1	1	5942	.013
22	5	2	2	1	3	1	2	5	5922	-.171
22	5	2	2	1	3	1	3	5	7962	-.720
22	5	2	2	1	3	1	4	1	4863	.239
22	6	2	1	1	2	5	1	5	6563	-.300
22	6	2	1	1	2	5	2	1	6585	.067
22	6	2	1	1	2	5	3	1	3531	.585
22	6	2	1	1	2	5	4	1	2058	.428

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
23	1	1	2	3	1	2	1	1	1234	.821
23	1	1	2	3	1	2	2	0	0	1.000
23	1	1	2	3	1	2	3	0	0	1.000
23	1	1	2	3	1	2	4	0	0	1.000
23	2	1	2	2	3	3	1	1	2203	.689
23	2	1	2	2	3	3	2	1	4745	.388
23	2	1	2	2	3	3	3	1	2862	.333
23	2	1	2	2	3	3	4	1	2975	.360
23	3	1	2	1	2	4	1	1	2361	.642
23	3	1	2	1	2	4	2	0	0	1.000
23	3	1	2	1	2	4	3	0	0	1.000
23	3	1	2	1	2	4	4	0	0	1.000
23	4	1	1	1	4	1	1	1	412	.932
23	4	1	1	1	4	1	2	1	686	.864
23	4	1	1	1	4	1	3	1	3981	.140
23	4	1	1	1	4	1	4	1	3644	.399
23	5	2	2	1	6	6	1	1	3029	.455
23	5	2	2	1	6	6	2	1	746	.791
23	5	2	2	1	6	6	3	1	5531	.579
23	5	2	2	1	6	6	4	1	4324	.414
23	6	2	1	1	5	5	1	1	1018	.798
23	6	2	1	1	5	5	2	1	3379	.521
23	6	2	1	1	5	5	3	1	4657	.453
23	6	2	1	1	5	5	4	1	1105	.693
24	1	1	2	3	6	3	1	1	4519	.362
24	1	1	2	3	6	3	2	1	4783	.383
24	1	1	2	3	6	3	3	5	4576	-.066
24	1	1	2	3	6	3	4	1	3050	.344
24	2	1	2	2	2	6	1	1	3775	.320
24	2	1	2	2	2	6	2	1	856	.761
24	2	1	2	2	2	6	3	1	5926	.548
24	2	1	2	2	2	6	4	1	3644	.506
24	3	1	2	1	1	1	1	0	0	1.000
24	3	1	2	1	1	1	2	1	2647	.477
24	3	1	2	1	1	1	3	1	2099	.547
24	3	1	2	1	1	1	4	1	2177	.660
24	4	1	1	1	5	2	1	1	4290	.376
24	4	1	1	1	5	2	2	1	1038	.692
24	4	1	1	1	5	2	3	0	0	1.000
24	4	1	1	1	5	2	4	1	2[illegible]18	.573
24	5	2	2	1	3	4	1	1	2837	.569
24	5	2	2	1	3	4	2	1	2837	.374
24	5	2	2	1	3	4	3	1	4[illegible]83	.540
24	5	2	2	1	3	4	4	1	1781	.585
24	6	2	1	1	4	5	1	5	6585	-.305
24	6	2	1	1	4	5	2	1	6671	.055
24	6	2	1	1	4	5	3	1	6693	.214
24	6	2	1	1	4	5	4	5	5935	-.651

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
25	1	1	2	3	4	3	1	1	3540	.500
25	1	1	2	3	4	3	2	1	3163	.592
25	1	1	2	3	4	3	3	1	3634	.154
25	1	1	2	3	4	3	4	1	2900	.377
25	2	1	2	2	5	6	1	1	4192	.245
25	2	1	2	2	5	6	2	0	0	1.000
25	2	1	2	2	5	6	3	1	7617	.420
25	2	1	2	2	5	6	4	1	4785	.351
25	3	1	2	1	6	1	1	1	5373	.107
25	3	1	2	1	6	1	2	1	2683	.430
25	3	1	2	1	6	1	3	1	1686	.636
25	3	1	2	1	6	1	4	1	4683	.236
25	4	1	1	1	3	2	1	1	2605	.621
25	4	1	1	1	3	2	2	1	1783	.471
25	4	1	1	1	3	2	3	1	1352	.860
25	4	1	1	1	3	2	4	0	0	1.000
25	5	2	2	1	2	4	1	1	3293	.500
25	5	2	2	1	2	4	2	0	0	1.000
25	5	2	2	1	2	4	3	1	4535	.501
25	5	2	2	1	2	4	4	1	1760	.589
25	6	2	1	1	1	5	1	1	2751	.455
25	6	2	1	1	1	5	2	1	4830	.316
25	6	2	1	1	1	5	3	1	6931	.186
25	6	2	1	1	1	5	4	1	1841	.488
26	1	1	2	3	4	4	1	1	2651	.597
26	1	1	2	3	4	4	2	0	0	1.000
26	1	1	2	3	4	4	3	1	1470	.838
26	1	1	2	3	4	4	4	1	124	.971
26	2	1	2	2	1	5	1	1	3271	.352
26	2	1	2	2	1	5	2	1	3466	.509
26	2	1	2	2	1	5	3	1	5827	.316
26	2	1	2	2	1	5	4	0	0	1.000
26	3	1	2	1	3	2	1	1	3428	.501
26	3	1	2	1	3	2	2	1	1371	.593
26	3	1	2	1	3	2	3	0	0	1.000
26	3	1	2	1	3	2	4	0	0	1.000
26	4	1	1	1	2	6	1	1	768	.662
26	4	1	1	1	2	6	2	0	0	1.000
26	4	1	1	1	2	6	3	1	3051	.768
26	4	1	1	1	2	6	4	1	505	.932
26	5	2	2	1	5	1	1	1	980	.837
26	5	2	2	1	5	1	2	1	3510	.306
26	5	2	2	1	5	1	3	1	1569	.661
26	5	2	2	1	5	1	4	1	1588	.752
26	6	2	1	1	6	3	1	1	5385	.239
26	6	2	1	1	6	3	2	1	2975	.617
26	6	2	1	1	6	3	3	1	2354	.452
26	6	2	1	1	6	3	4	1	1977	.575

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
27	1	1	2	3	2	5	1	1	2036	.597
27	1	1	2	3	2	5	2	1	3596	.491
27	1	1	2	3	2	5	3	1	3834	.550
27	1	1	2	3	2	5	4	1	0	1.000
27	2	1	2	2	3	1	1	1	2726	.547
27	2	1	2	2	3	1	2	1	2412	.523
27	2	1	2	2	3	1	3	1	1745	.623
27	2	1	2	2	3	1	4	1	980	.847
27	3	1	2	1	4	6	1	1	3271	.411
27	3	1	2	1	4	6	2	0	0	1.000
27	3	1	2	1	4	6	3	0	0	1.000
27	3	1	2	1	4	6	4	0	0	1.000
27	4	1	1	1	1	3	1	1	5009	.293
27	4	1	1	1	1	3	2	1	1827	.765
27	4	1	1	1	1	3	3	1	1563	.636
27	4	1	1	1	1	3	4	1	2109	.547
27	5	2	2	1	5	2	1	1	3213	.533
27	5	2	2	1	5	2	2	1	1313	.610
27	5	2	2	1	5	2	3	1	2410	.751
27	5	2	2	1	5	2	4	1	2233	.527
27	6	2	1	1	6	4	1	1	3272	.503
27	6	2	1	1	6	4	2	1	2112	.534
27	6	2	1	1	6	4	3	1	4142	.544
27	6	2	1	1	6	4	4	1	1553	.638
28	1	1	2	3	4	5	1	1	3119	.382
28	1	1	2	3	4	5	2	1	4614	.347
28	1	1	2	3	4	5	3	0	0	1.000
28	1	1	2	3	4	5	4	1	628	.825
28	2	1	2	2	3	2	1	1	4075	.407
28	2	1	2	2	3	2	2	1	1469	.504
28	2	1	2	2	3	2	3	1	4917	.491
28	2	1	2	2	3	2	4	0	0	1.000
28	3	1	2	1	5	3	1	1	4199	.407
28	3	1	2	1	5	3	2	1	3032	.609
28	3	1	2	1	5	3	3	1	1167	.728
28	3	1	2	1	5	3	4	1	2900	.377
28	4	1	1	1	2	1	1	1	765	.873
28	4	1	1	1	2	1	2	0	0	1.000
28	4	1	1	1	2	1	3	1	1981	.572
28	4	1	1	1	2	1	4	1	2902	.546
28	5	2	2	1	6	4	1	1	2692	.591
28	5	2	2	1	6	4	2	1	1657	.635
28	5	2	2	1	6	4	3	1	5136	.435
28	5	2	2	1	6	4	4	1	932	.783
28	6	2	1	1	1	6	1	1	3622	.348
28	6	2	1	1	1	6	2	1	2393	.331
28	6	2	1	1	1	6	3	1	5905	.550
28	6	2	1	1	1	6	4	1	5224	.292

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
29	1	1	2	3	2	4	1	1	3210	.513
29	1	1	2	3	2	4	2	0	0	1.000
29	1	1	2	3	2	4	3	1	2837	.688
29	1	1	2	3	2	4	4	0	0	1.000
29	2	1	2	2	5	1	1	1	1275	.788
29	2	1	2	2	5	1	2	1	3000	.407
29	2	1	2	2	5	1	3	1	2255	.513
29	2	1	2	2	5	1	4	1	2020	.634
29	3	1	2	1	4	3	1	1	4312	.391
29	3	1	2	1	4	3	2	1	[illegible]	.859
29	3	1	2	1	4	3	3	1	1262	.706
29	3	1	2	1	4	3	4	1	3069	.340
29	4	1	1	1	3	6	1	1	3424	.383
29	4	1	1	1	3	6	2	0	0	1.000
29	4	1	1	1	3	6	3	1	5027	.617
29	4	1	1	1	3	6	4	1	2129	.711
29	5	2	2	1	1	5	1	1	3184	.369
29	5	2	2	1	1	5	2	1	4635	.344
29	5	2	2	1	1	5	3	1	5177	.392
29	5	2	2	1	1	5	4	1	1819	.494
29	6	2	1	1	6	2	1	1	4369	.365
29	6	2	1	1	6	2	2	1	[illegible]	.401
29	6	2	1	1	6	2	3	1	1371	.858
29	6	2	1	1	6	2	4	1	3918	.170
30	1	1	2	3	6	6	1	1	3424	.383
30	1	1	2	3	6	6	2	0	0	1.000
30	1	1	2	3	6	6	3	1	4149	.684
30	1	1	2	3	6	6	4	1	7287	.012
30	2	1	2	2	5	2	1	5	7973	-.160
30	2	1	2	2	5	2	2	1	2645	.215
30	2	1	2	2	5	2	3	1	4956	.487
30	2	1	2	2	5	2	4	0	0	1.000
30	3	1	2	1	2	3	1	1	2806	.604
30	3	1	2	1	2	3	2	1	4500	.420
30	3	1	2	1	2	3	3	1	2222	.482
30	3	1	2	1	2	3	4	1	3088	.336
30	4	1	1	1	1	4	1	1	1905	.711
30	4	1	1	1	1	4	2	1	1574	.653
30	4	1	1	1	1	4	3	1	5198	.428
30	4	1	1	1	1	4	4	0	0	1.000
30	5	2	2	1	4	1	1	1	2569	.573
30	5	2	2	1	4	1	2	1	3451	.318
30	5	2	2	1	4	1	3	5	8785	-.898
30	5	2	2	1	4	1	4	5	6530	-.021
30	6	2	1	1	3	5	1	5	6390	-.266
30	6	2	1	1	3	5	2	5	8209	-.163
30	6	2	1	1	3	5	3	1	6433	.244
30	6	2	1	1	3	5	4	1	1971	.452

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
31	1	1	2	3	1	4	1	1	3086	.531
31	1	1	2	3	1	4	2	1	932	.795
31	1	1	2	3	1	4	3	1	2133	.765
31	1	1	2	3	1	4	4	0	0	1.000
31	2	1	2	2	6	2	1	1	4467	.350
31	2	1	2	2	6	2	2	1	2312	.314
31	2	1	2	2	6	2	3	1	3644	.623
31	2	1	2	2	6	2	4	0	0	1.000
31	3	1	2	1	5	1	1	1	2177	.638
31	3	1	2	1	5	1	2	1	3647	.279
31	3	1	2	1	5	1	3	1	1981	.572
31	3	1	2	1	5	1	4	1	2294	.641
31	4	1	1	1	2	5	1	1	2621	.481
31	4	1	1	1	2	5	2	1	4007	.433
31	4	1	1	1	2	5	3	1	5415	.364
31	4	1	1	1	2	5	4	1	888	.753
31	5	2	2	1	3	6	1	1	3885	.300
31	5	2	2	1	3	6	2	1	2632	.209
31	5	2	2	1	3	6	3	1	5817	.557
31	5	2	2	1	3	6	4	5	11370	-.542
31	6	2	1	1	4	3	1	1	5423	.234
31	6	2	1	1	4	3	2	1	5837	.246
31	6	2	1	1	4	3	3	1	2636	.386
31	6	2	1	1	4	3	4	1	3107	.332
32	1	1	2	3	4	1	1	1	1824	.697
32	1	1	2	3	4	1	2	1	2177	.570
32	1	1	2	3	4	1	3	1	2118	.542
32	1	1	2	3	4	1	4	1	3824	.402
32	2	1	2	2	1	2	1	1	2586	.624
32	2	1	2	2	1	2	2	1	1724	.488
32	2	1	2	2	1	2	3	1	1410	.854
32	2	1	2	2	1	2	4	1	3546	.249
32	3	1	2	1	2	5	1	0	0	1.000
32	3	1	2	1	2	5	2	1	3877	.451
32	3	1	2	1	2	5	3	1	4635	.455
32	3	1	2	1	2	5	4	1	1300	.639
32	4	1	1	1	3	4	1	1	3334	.494
32	4	1	1	1	3	4	2	1	2050	.548
32	4	1	1	1	3	4	3	1	2962	.674
32	4	1	1	1	3	4	4	1	953	.778
32	5	2	2	1	6	3	1	1	6007	.152
32	5	2	2	1	6	3	2	1	4500	.420
32	5	2	2	1	6	3	3	1	2467	.425
32	5	2	2	1	6	3	4	1	3804	.182
32	6	2	1	1	5	6	1	1	3753	.324
32	6	2	1	1	5	6	2	1	2458	.313
32	6	2	1	1	5	6	3	1	5561	.554
32	6	2	1	1	5	6	4	1	5707	.226

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
33	1	1	2	3	5	3	1	1	4764	.327
33	1	1	2	3	5	3	2	1	6270	.192
33	1	1	2	3	5	3	3	5	4595	-.070
33	1	1	2	3	5	3	4	1	2900	.377
33	2	1	2	2	6	5	1	1	4332	.142
33	2	1	2	2	6	5	2	1	3076	.564
33	2	1	2	2	6	5	3	1	5242	.384
33	2	1	2	2	6	5	4	1	2101	.416
33	3	1	2	1	3	1	1	1	3746	.378
33	3	1	2	1	3	1	2	1	2432	.519
33	3	1	2	1	3	1	3	1	1294	.720
33	3	1	2	1	3	1	4	1	2118	.669
33	4	1	1	1	4	4	1	5	10707	-.626
33	4	1	1	1	4	4	2	1	3500	.228
33	4	1	1	1	4	4	3	1	3169	.651
33	4	1	1	1	4	4	4	1	1222	.715
33	5	2	2	1	1	6	1	1	3073	.447
33	5	2	2	1	1	6	2	0	0	1.000
33	5	2	2	1	1	6	3	1	3205	.756
33	5	2	2	1	1	6	4	1	4695	.336
33	6	2	1	1	2	2	1	1	2174	.684
33	6	2	1	1	2	2	2	0	0	1.000
33	6	2	1	1	2	2	3	0	0	1.000
33	6	2	1	1	2	2	4	1	3311	.299
34	1	1	2	3	3	3	1	1	772	.891
34	1	1	2	3	3	3	2	1	1601	.794
34	1	1	2	3	3	3	3	1	1337	.689
34	1	1	2	3	3	3	4	1	2203	.526
34	2	1	2	2	6	1	1	1	2294	.619
34	2	1	2	2	6	1	2	5	6020	-.190
34	2	1	2	2	6	1	3	1	2020	.564
34	2	1	2	2	6	1	4	1	4942	.227
34	3	1	2	1	2	2	1	1	2077	.698
34	3	1	2	1	2	2	2	1	623	.756
34	3	1	2	1	2	2	3	0	0	1.000
34	3	1	2	1	2	2	4	1	1489	.685
34	4	1	1	1	1	5	1	0	0	1.000
34	4	1	1	1	1	5	2	1	4267	.396
34	4	1	1	1	1	5	3	1	3509	.588
34	4	1	1	1	1	5	4	1	1993	.446
34	5	2	2	1	5	4	1	5	12902	-.959
34	5	2	2	1	5	4	2	1	2402	.470
34	5	2	2	1	5	4	3	1	5302	.417
34	5	2	2	1	5	4	4	1	3334	.222
34	6	2	1	1	4	6	1	5	6673	-.202
34	6	2	1	1	4	6	2	1	3507	.160
34	6	2	1	1	4	6	3	1	11392	.132
34	6	2	1	1	4	6	4	1	4695	.336

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
35	1	1	2	3	1	6	1	1	3402	.387
35	1	1	2	3	1	6	2	0	0	1.000
35	1	1	2	3	1	6	3	1	4412	.664
35	1	1	2	3	1	6	4	1	4149	.438
35	2	1	2	2	2	5	1	1	3509	.305
35	2	1	2	2	2	5	2	1	4744	.328
35	2	1	2	2	2	5	3	1	8014	.059
35	2	1	2	2	2	5	4	1	1993	.446
35	3	1	2	1	3	4	1	1	3086	.531
35	3	1	2	1	3	4	2	0	0	1.000
35	3	1	2	1	3	4	3	1	2796	.692
35	3	1	2	1	3	4	4	1	311	.928
35	4	1	1	1	4	3	1	1	5461	.229
35	4	1	1	1	4	3	2	1	4030	.481
35	4	1	1	1	4	3	3	1	2467	.425
35	4	1	1	1	4	3	4	1	2787	.401
35	5	2	2	1	5	2	1	1	5270	.234
35	5	2	2	1	6	2	2	1	2312	.314
35	5	2	2	1	6	2	3	1	5289	.452
35	5	2	2	1	6	2	4	0	0	1.000
35	6	2	1	1	5	1	1	1	2432	.596
35	6	2	1	1	5	1	2	1	3902	.229
35	6	2	1	1	5	1	3	5	6687	-.445
35	6	2	1	1	5	1	4	1	5099	.202
36	1	1	2	3	2	1	1	0	0	1.000
36	1	1	2	3	2	1	2	1	2079	.589
36	1	1	2	3	2	1	3	1	20	.996
36	1	1	2	3	2	1	4	1	3157	.506
36	2	1	2	2	3	4	1	5	9154	-.390
36	2	1	2	2	3	4	2	1	1325	.708
36	2	1	2	2	3	4	3	1	3666	.597
36	2	1	2	2	3	4	4	1	21	.995
36	3	1	2	1	1	2	1	1	3389	.507
36	3	1	2	1	1	2	2	1	1665	.506
36	3	1	2	1	1	2	3	1	940	.903
36	3	1	2	1	1	2	4	0	0	1.000
36	4	1	1	1	4	6	1	1	2349	.577
36	4	1	1	1	4	6	2	0	0	1.000
36	4	1	1	1	4	6	3	1	5290	.597
36	4	1	1	1	4	6	4	1	2371	.679
36	5	2	2	1	6	5	1	5	5242	-.039
36	5	2	2	1	6	5	2	5	7083	-.003
36	5	2	2	1	6	5	3	1	5740	.326
36	5	2	2	1	6	5	4	5	7646	-1.127
36	6	2	1	1	5	3	1	1	5875	.170
36	6	2	1	1	5	3	2	5	8605	-.109
36	6	2	1	1	5	3	3	1	2843	.338
36	6	2	1	1	5	3	4	1	4312	.073

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
37	1	1	2	3	4	4	1	1	3044	.538
37	1	1	2	3	4	4	2	1	1905	.580
37	1	1	2	3	4	4	3	1	3873	.574
37	1	1	2	3	4	4	4	0	0	1.000
37	2	1	2	2	2	5	1	0	0	1.000
37	2	1	2	2	2	5	2	1	4484	.365
37	2	1	2	2	2	5	3	1	4310	.494
37	2	1	2	2	2	5	4	1	1663	.482
37	3	1	2	1	3	1	1	1	3157	.476
37	3	1	2	1	3	1	2	1	2824	.442
37	3	1	2	1	3	1	3	1	2373	.437
37	3	1	2	1	3	1	4	1	4942	.227
37	4	1	1	1	5	3	1	1	3747	.471
37	4	1	1	1	5	3	2	1	3371	.566
37	4	1	1	1	5	3	3	1	2165	.496
37	4	1	1	1	5	3	4	1	4350	.065
37	5	2	2	1	6	2	1	1	5191	.245
37	5	2	2	1	6	2	2	1	2096	.378
37	5	2	2	1	6	2	3	1	4604	.523
37	5	2	2	1	6	2	4	0	0	1.000
37	6	2	1	1	1	6	1	1	3907	.296
37	6	2	1	1	1	6	2	1	3227	.098
37	6	2	1	1	1	6	3	1	5861	.554
37	6	2	1	1	1	6	4	1	3534	.521
38	1	1	2	3	2	4	1	1	2195	.667
38	1	1	2	3	2	4	2	0	0	1.000
38	1	1	2	3	2	4	3	0	0	1.000
38	1	1	2	3	2	4	4	0	0	1.000
38	2	1	2	2	3	2	1	1	4447	.353
38	2	1	2	2	3	2	2	1	1822	.459
38	2	1	2	2	3	2	3	1	5093	.473
38	2	1	2	2	3	2	4	0	0	1.000
38	3	1	2	1	6	3	1	1	5216	.263
38	3	1	2	1	6	3	2	1	3182	.590
38	3	1	2	1	6	3	3	1	2222	.482
38	3	1	2	1	6	3	4	1	3597	.227
38	4	1	1	1	1	6	1	1	3710	.332
38	4	1	1	1	1	6	2	0	0	1.000
38	4	1	1	1	1	6	3	1	5707	.565
38	4	1	1	1	1	6	4	1	3314	.551
38	5	2	2	1	5	5	1	1	3726	.262
38	5	2	2	1	5	5	2	1	5545	.215
38	5	2	2	1	5	5	3	1	4137	.514
38	5	2	2	1	5	5	4	5	3639	-.012
38	6	2	1	1	4	1	1	1	3659	.492
38	6	2	1	1	4	1	2	1	4197	.171
38	6	2	1	1	4	1	3	5	7707	-.665
38	6	2	1	1	4	1	4	1	4706	.264

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
39	1	1	2	3	2	1	1	1	4569	.241
39	1	1	2	3	2	1	2	1	2236	.558
39	1	1	2	3	2	1	3	1	1686	.636
39	1	1	2	3	2	1	4	1	4353	.319
39	2	1	2	2	1	4	1	5	11846	-.799
39	2	1	2	2	1	4	2	0	0	1.000
39	2	1	2	2	1	4	3	1	4929	.458
39	2	1	2	2	1	4	4	0	0	1.000
39	3	1	2	1	3	5	1	1	1668	.670
39	3	1	2	1	3	5	2	0	0	1.000
39	3	1	2	1	3	5	3	1	3985	.532
39	3	1	2	1	3	5	4	0	0	1.000
39	4	1	1	1	4	3	1	1	3126	.559
39	4	1	1	1	4	3	2	1	2260	.709
39	4	1	1	1	4	3	3	1	1186	.724
39	4	1	1	1	4	3	4	1	3145	.324
39	5	2	2	1	5	6	1	1	5180	.067
39	5	2	2	1	5	6	2	1	1690	.528
39	5	2	2	1	5	6	3	1	5619	.572
39	5	2	2	1	5	6	4	1	5070	.313
39	6	2	1	1	6	2	1	1	4839	.296
39	6	2	1	1	6	2	2	1	2272	.326
39	6	2	1	1	6	2	3	1	2018	.791
39	6	2	1	1	6	2	4	0	0	1.000
40	1	1	2	3	5	6	1	1	3424	.383
40	1	1	2	3	5	6	2	1	1471	.589
40	1	1	2	3	5	6	3	1	5641	.570
40	1	1	2	3	5	6	4	1	2766	.625
40	2	1	2	2	2	4	1	1	3148	.522
40	2	1	2	2	2	4	2	0	0	1.000
40	2	1	2	2	2	4	3	1	4038	.556
40	2	1	2	2	2	4	4	1	891	.792
40	3	1	2	1	3	2	1	1	4290	.376
40	3	1	2	1	3	2	2	1	1665	.506
40	3	1	2	1	3	2	3	1	1136	.882
40	3	1	2	1	3	2	4	0	0	1.000
40	4	1	1	1	4	5	1	1	2123	.579
40	4	1	1	1	4	5	2	1	4679	.337
40	4	1	1	1	4	5	3	1	2859	.664
40	4	1	1	1	4	5	4	1	2188	.392
40	5	2	2	1	1	1	1	0	0	1.000
40	5	2	2	1	1	1	2	1	3746	.260
40	5	2	2	1	1	1	3	5	5373	-.161
40	5	2	2	1	1	1	4	1	1706	.733
40	6	2	1	1	6	3	1	1	4670	.340
40	6	2	1	1	6	3	2	1	5781	.255
40	6	2	1	1	6	3	3	1	3276	.237
40	6	2	1	1	6	3	4	1	3032	.348

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
41	1	1	2	3	2	2	1	1	1038	.849
41	1	1	2	3	2	2	2	1	823	.756
41	1	1	2	3	2	2	3	1	682	.909
41	1	1	2	3	2	2	4	0	0	1.000
41	2	1	2	2	3	5	1	1	1733	.657
41	2	1	2	2	3	5	2	1	2989	.577
41	2	1	2	2	3	5	3	1	3985	.532
41	2	1	2	2	3	5	4	1	650	.819
41	3	1	2	1	4	6	1	1	3007	.458
41	3	1	2	1	4	6	2	1	1010	.718
41	3	1	2	1	4	6	3	1	5466	.584
41	3	1	2	1	4	6	4	1	1646	.777
41	4	1	1	1	1	1	1	1	1530	.746
41	4	1	1	1	1	1	2	1	2216	.562
41	4	1	1	1	1	1	3	1	1706	.631
41	4	1	1	1	1	1	4	1	1686	.736
41	5	2	2	1	6	4	1	1	2589	.607
41	5	2	2	1	6	4	2	1	1346	.703
41	5	2	2	1	6	4	3	1	2361	.740
41	5	2	2	1	6	4	4	1	1408	.671
41	6	2	1	1	5	3	1	1	3935	.444
41	6	2	1	1	5	3	2	1	3634	.532
41	6	2	1	1	5	3	3	1	1732	.596
41	6	2	1	1	5	3	4	1	2410	.482
42	1	1	2	3	5	3	1	1	4293	.394
42	1	1	2	3	5	3	2	1	2599	.665
42	1	1	2	3	5	3	3	1	1619	.623
42	1	1	2	3	5	3	4	1	2862	.385
42	2	1	2	2	1	6	1	1	3578	.356
42	2	1	2	2	1	6	2	1	637	.822
42	2	1	2	2	1	6	3	1	4939	.624
42	2	1	2	2	1	6	4	1	1471	.801
42	3	1	2	1	4	5	1	1	2643	.476
42	3	1	2	1	4	5	2	1	5025	.288
42	3	1	2	1	4	5	3	1	5415	.364
42	3	1	2	1	4	5	4	1	2036	.434
42	4	1	1	1	6	1	1	1	2314	.616
42	4	1	1	1	6	1	2	1	2843	.438
42	4	1	1	1	6	1	3	1	2530	.453
42	4	1	1	1	6	1	4	1	2451	.617
42	5	2	2	1	3	2	1	1	3311	.519
42	5	2	2	1	3	2	2	1	2214	.343
42	5	2	2	1	3	2	3	0	0	1.000
42	5	2	2	1	3	2	4	1	3761	.203
42	6	2	1	1	2	4	1	1	3562	.459
42	6	2	1	1	2	4	2	1	2133	.530
42	6	2	1	1	2	4	3	1	3396	.626
42	6	2	1	1	2	4	4	1	2651	.382

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
43	1	1	2	3	4	6	1	1	5027	.095
43	1	1	2	3	4	6	2	1	3292	.080
43	1	1	2	3	4	6	3	1	2700	.794
43	1	1	2	3	4	6	4	1	4631	.372
43	2	1	2	2	2	3	1	1	3935	.444
43	2	1	2	2	2	3	2	1	5442	.299
43	2	1	2	2	2	3	3	1	3163	.263
43	2	1	2	2	2	3	4	1	4048	.130
43	3	1	2	1	3	4	1	1	2672	.594
43	3	1	2	1	3	4	2	0	0	1.000
43	3	1	2	1	3	4	3	1	3562	.608
43	3	1	2	1	3	4	4	0	0	1.000
43	4	1	1	1	5	2	1	1	4878	.291
43	4	1	1	1	5	2	2	1	2096	.378
43	4	1	1	1	5	2	3	1	2077	.785
43	4	1	1	1	5	2	4	0	0	1.000
43	5	2	2	1	6	1	1	1	3314	.450
43	5	2	2	1	6	1	2	1	451	.911
43	5	2	2	1	6	1	3	5	7746	-.674
43	5	2	2	1	6	1	4	1	4706	.264
43	6	2	1	1	1	5	1	1	3834	.240
43	6	2	1	1	1	5	2	1	4549	.356
43	6	2	1	1	1	5	3	1	6476	.239
43	6	2	1	1	1	5	4	5	5480	-.524
44	1	1	2	3	1	4	1	1	3148	.522
44	1	1	2	3	1	4	2	0	0	1.000
44	1	1	2	3	1	4	3	1	1885	.793
44	1	1	2	3	1	4	4	0	0	1.000
44	2	1	2	2	4	5	1	1	3812	.245
44	2	1	2	2	4	5	2	1	2816	.601
44	2	1	2	2	4	5	3	1	6325	.257
44	2	1	2	2	4	5	4	1	1603	.554
44	3	1	2	1	2	6	1	1	2656	.522
44	3	1	2	1	2	6	2	0	0	1.000
44	3	1	2	1	2	6	3	1	3292	.749
44	3	1	2	1	2	6	4	0	0	1.000
44	4	1	1	1	3	2	1	1	4408	.359
44	4	1	1	1	3	2	2	1	2057	.390
44	4	1	1	1	3	2	3	1	411	.957
44	4	1	1	1	3	2	4	0	0	1.000
44	5	2	2	1	5	3	1	1	5084	.282
44	5	2	2	1	5	3	2	1	6892	.112
44	5	2	2	1	5	3	3	1	2467	.425
44	5	2	2	1	5	3	4	1	3935	.154
44	6	2	1	1	6	1	1	1	4687	.221
44	6	2	1	1	6	1	2	1	3589	.291
44	6	2	1	1	6	1	3	5	4902	-.059
44	6	2	1	1	6	1	4	1	5236	.181

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
45	1	1	2	3	1	5	1	1	1819	.639
45	1	1	2	3	1	5	2	1	5870	.169
45	1	1	2	3	1	5	3	1	5632	.338
45	1	1	2	3	1	5	4	0	0	1.000
45	2	1	2	2	6	4	1	1	5985	.091
45	2	1	2	2	6	4	2	1	2754	.393
45	2	1	2	2	6	4	3	1	6689	.264
45	2	1	2	2	6	4	4	5	4349	-.014
45	3	1	2	1	5	6	1	1	2371	.573
45	3	1	2	1	5	6	2	1	3051	.147
45	3	1	2	1	5	6	3	1	6080	.537
45	3	1	2	1	5	6	4	1	5180	.298
45	4	1	1	1	4	1	1	1	4883	.189
45	4	1	1	1	4	1	2	1	3138	.380
45	4	1	1	1	4	1	3	1	2981	.356
45	4	1	1	1	4	1	4	1	1941	.696
45	5	2	2	1	2	3	1	1	5348	.245
45	5	2	2	1	2	3	2	1	6666	.141
45	5	2	2	1	2	3	3	1	2881	.329
45	5	2	2	1	2	3	4	1	4632	.004
45	6	2	1	1	3	2	1	1	2841	.587
45	6	2	1	1	3	2	2	0	0	1.000
45	6	2	1	1	3	2	3	1	2312	.761
45	6	2	1	1	3	2	4	0	0	1.000
46	1	1	2	3	5	2	1	1	4153	.396
46	1	1	2	3	5	2	2	1	1939	.424
46	1	1	2	3	5	2	3	1	2233	.769
46	1	1	2	3	5	2	4	1	803	.830
46	2	1	2	2	6	1	1	1	4334	.280
46	2	1	2	2	6	1	2	1	3589	.291
46	2	1	2	2	6	1	3	1	1824	.606
46	2	1	2	2	6	1	4	1	3863	.396
46	3	1	2	1	1	5	1	1	1884	.627
46	3	1	2	1	1	5	2	1	3271	.537
46	3	1	2	1	1	5	3	1	4245	.501
46	3	1	2	1	1	5	4	0	0	1.000
46	4	1	1	1	2	6	1	1	2414	.565
46	4	1	1	1	2	6	2	1	3402	.049
46	4	1	1	1	2	6	3	1	4785	.635
46	4	1	1	1	2	6	4	1	4588	.378
46	5	2	2	1	3	3	1	1	5028	.290
46	5	2	2	1	3	3	2	1	3622	.507
46	5	2	2	1	3	3	3	5	5593	-.303
46	5	2	2	1	3	3	4	1	3220	.308
46	6	2	1	1	4	4	1	1	3086	.531
46	6	2	1	1	4	4	2	1	2402	.470
46	6	2	1	1	4	4	3	1	3376	.629
46	6	2	1	1	4	4	4	1	1615	.623

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
47	1	1	2	3	6	1	1	1	2334	.612
47	1	1	2	3	6	1	2	1	2804	.446
47	1	1	2	3	6	1	3	1	2137	.538
47	1	1	2	3	6	1	4	1	4628	.276
47	2	1	2	2	3	6	1	1	2722	.510
47	2	1	2	2	3	6	2	1	790	.779
47	2	1	2	2	3	6	3	1	5356	.592
47	2	1	2	2	3	6	4	1	3205	.565
47	3	1	2	1	2	4	1	1	3169	.519
47	3	1	2	1	2	4	2	1	1429	.685
47	3	1	2	1	2	4	3	1	5012	.449
47	3	1	2	1	2	4	4	1	704	.836
47	4	1	1	1	1	5	1	1	2101	.584
47	4	1	1	1	1	5	2	1	4245	.399
47	4	1	1	1	1	5	3	1	5805	.318
47	4	1	1	1	1	5	4	1	1040	.711
47	5	2	2	1	5	2	1	1	4564	.336
47	5	2	2	1	5	2	2	1	2174	.355
47	5	2	2	1	5	2	3	1	1587	.836
47	5	2	2	1	5	2	4	1	2801	.407
47	6	2	1	1	4	3	1	1	5969	.157
47	6	2	1	1	4	3	2	1	3484	.551
47	6	2	1	1	4	3	3	1	2147	.500
47	6	2	1	1	4	3	4	1	3220	.308
48	1	1	2	3	1	1	1	1	1608	.733
48	1	1	2	3	1	1	2	1	2706	.465
48	1	1	2	3	1	1	3	1	2353	.492
48	1	1	2	3	1	1	4	1	1490	.767
48	2	1	2	2	6	6	1	1	2590	.534
48	2	1	2	2	6	6	2	1	1734	.515
48	2	1	2	2	6	6	3	1	5027	.617
48	2	1	2	2	6	6	4	1	3446	.533
48	3	1	2	1	2	2	1	1	2919	.575
48	3	1	2	1	2	2	2	0	0	1.000
48	3	1	2	1	2	2	3	0	0	1.000
48	3	1	2	1	2	2	4	1	1215	.743
48	4	1	1	1	3	5	1	1	2686	.468
48	4	1	1	1	3	5	2	0	0	1.000
48	4	1	1	1	3	5	3	1	2686	.684
48	4	1	1	1	3	5	4	1	1170	.675
48	5	2	2	1	4	3	1	1	4670	.340
48	5	2	2	1	4	3	2	1	3484	.551
48	5	2	2	1	4	3	3	0	0	1.000
48	5	2	2	1	4	3	4	1	3032	.348
48	6	2	1	1	5	4	1	1	3396	.434
48	6	2	1	1	5	4	2	1	1905	.580
48	6	2	1	1	5	4	3	1	4701	.483
48	6	2	1	1	5	4	4	1	3541	.174

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
49	1	1	2	3	4	5	1	1	2209	.562
49	1	1	2	3	4	5	2	1	4440	.371
49	1	1	2	3	4	5	3	1	6910	.188
49	1	1	2	3	4	5	4	1	1386	.614
49	2	1	2	2	6	3	1	1	4011	.434
49	2	1	2	2	6	3	2	1	3088	.602
49	2	1	2	2	6	3	3	1	1431	.667
49	2	1	2	2	6	3	4	1	3032	.348
49	3	1	2	1	1	2	1	1	2723	.604
49	3	1	2	1	1	2	2	1	1254	.628
49	3	1	2	1	1	2	3	1	1489	.846
49	3	1	2	1	1	2	4	0	0	1.000
49	4	1	1	1	5	4	1	1	3438	.478
49	4	1	1	1	5	4	2	1	1864	.589
49	4	1	1	1	5	4	3	1	4453	.510
49	4	1	1	1	5	4	4	1	1077	.749
49	5	2	2	1	2	6	1	1	3666	.340
49	5	2	2	1	2	6	2	1	3249	.092
49	5	2	2	1	2	6	3	1	5575	.575
49	5	2	2	1	2	6	4	1	3841	.479
49	6	2	1	1	3	1	1	1	2608	.567
49	6	2	1	1	3	1	2	1	2941	.419
49	6	2	1	1	3	1	3	1	2353	.492
49	6	2	1	1	3	1	4	1	4648	.273
50	1	1	2	3	2	5	1	1	2967	.412
50	1	1	2	3	2	5	2	1	3357	.525
50	1	1	2	3	2	5	3	1	7018	.176
50	1	1	2	3	2	5	4	1	1733	.518
50	2	1	2	2	3	4	1	1	3355	.491
50	2	1	2	2	3	4	2	1	2030	.553
50	2	1	2	2	3	4	3	1	3935	.567
50	2	1	2	2	3	4	4	1	1388	.676
50	3	1	2	1	1	3	1	1	2297	.676
50	3	1	2	1	1	3	2	1	1280	.835
50	3	1	2	1	1	3	3	1	1638	.618
50	3	1	2	1	1	3	4	1	2975	.360
50	4	1	1	1	6	6	1	1	3929	.292
50	4	1	1	1	6	6	2	1	2436	.319
50	4	1	1	1	6	6	3	1	10887	.171
50	4	1	1	1	6	6	4	1	4236	.426
50	5	2	2	1	4	2	1	1	4800	.302
50	5	2	2	1	4	2	2	1	1626	.517
50	5	2	2	1	4	2	3	1	2508	.740
50	5	2	2	1	4	2	4	1	3644	.228
50	6	2	1	1	5	1	1	1	3373	.440
50	6	2	1	1	5	1	2	1	2863	.434
50	6	2	1	1	5	1	3	1	2706	.415
50	6	2	1	1	5	1	4	1	4902	.233

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
51	1	1	2	3	4	1	1	1	2236	.629
51	1	1	2	3	4	1	2	1	2843	.438
51	1	1	2	3	4	1	3	1	1804	.610
51	1	1	2	3	4	1	4	1	1569	.755
51	2	1	2	2	5	3	1	1	5065	.285
51	2	1	2	2	5	3	2	1	5178	.333
51	2	1	2	2	5	3	3	1	1845	.570
51	2	1	2	2	5	3	4	1	3013	.352
51	3	1	2	1	6	6	1	1	3292	.407
51	3	1	2	1	6	6	2	0	0	1.000
51	3	1	2	1	6	6	3	1	5400	.589
51	3	1	2	1	6	6	4	1	3490	.527
51	4	1	1	1	1	4	1	1	2879	.563
51	4	1	1	1	1	4	2	0	0	1.000
51	4	1	1	1	1	4	3	1	2237	.754
51	4	1	1	1	1	4	4	0	0	1.000
51	5	2	2	1	3	5	1	1	3076	.391
51	5	2	2	1	3	5	2	1	4375	.380
51	5	2	2	1	3	5	3	1	6216	.270
51	5	2	2	1	3	5	4	1	1863	.482
51	6	2	1	1	2	2	1	1	4075	.407
51	6	2	1	1	2	2	2	1	1881	.442
51	6	2	1	1	2	2	3	1	3800	.606
51	6	2	1	1	2	2	4	1	3565	.245
52	1	1	2	3	3	6	1	1	3336	.399
52	1	1	2	3	3	6	2	0	0	1.000
52	1	1	2	3	3	6	3	1	3797	.711
52	1	1	2	3	3	6	4	1	1624	.780
52	2	1	2	2	5	4	1	1	3314	.497
52	2	1	2	2	5	4	2	0	0	1.000
52	2	1	2	2	5	4	3	1	3707	.592
52	2	1	2	2	5	4	4	1	1056	.754
52	3	1	2	1	4	3	1	1	3634	.487
52	3	1	2	1	4	3	2	1	4067	.476
52	3	1	2	1	4	3	3	1	1996	.535
52	3	1	2	1	4	3	4	1	2937	.368
52	4	1	1	1	6	2	1	1	2743	.601
52	4	1	1	1	6	2	2	1	1646	.512
52	4	1	1	1	6	2	3	1	1626	.832
52	4	1	1	1	6	2	4	1	1234	.739
52	5	2	2	1	2	5	1	1	3985	.210
52	5	2	2	1	2	5	2	1	4440	.371
52	5	2	2	1	2	5	3	1	6910	.188
52	5	2	2	1	2	5	4	1	1495	.584
52	6	2	1	1	1	1	1	1	745	.876
52	6	2	1	1	1	1	2	1	2843	.438
52	6	2	1	1	1	1	3	1	2255	.513
52	6	2	1	1	1	1	4	0	0	1.000

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
53	1	1	2	3	3	2	1	1	2449	.644
53	1	1	2	3	3	2	2	0	0	1.000
53	1	1	2	3	3	2	3	1	3272	.661
53	1	1	2	3	3	2	4	1	2292	.515
53	2	1	2	2	4	6	1	1	3710	.332
53	2	1	2	2	4	6	2	1	3468	.631
53	2	1	2	2	4	6	3	1	5597	.574
53	2	1	2	2	4	6	4	1	4127	.440
53	3	1	2	1	2	5	1	1	3509	.305
53	3	1	2	1	2	5	2	1	3487	.506
53	3	1	2	1	2	5	3	1	3227	.621
53	3	1	2	1	2	5	4	1	1451	.596
53	4	1	1	1	1	3	1	1	4143	.415
53	4	1	1	1	1	3	2	1	2599	.665
53	4	1	1	1	1	3	3	0	0	1.000
53	4	1	1	1	1	3	4	1	2956	.364
53	5	2	2	1	5	1	1	1	3569	.407
53	5	2	2	1	5	1	2	1	3922	.225
53	5	2	2	1	5	1	3	1	3059	.339
53	5	2	2	1	5	1	4	1	4471	.301
53	6	2	1	1	6	4	1	1	3500	.469
53	6	2	1	1	6	4	2	1	1947	.571
53	6	2	1	1	6	4	3	1	6254	.312
53	6	2	1	1	6	4	4	1	3169	.261
54	1	1	2	3	6	5	1	1	282	.944
54	1	1	2	3	6	5	2	1	975	.862
54	1	1	2	3	6	5	3	1	4245	.501
54	1	1	2	3	6	5	4	1	628	.825
54	2	1	2	2	1	3	1	1	3201	.548
54	2	1	2	2	1	3	2	1	4482	.422
54	2	1	2	2	1	3	3	1	471	.890
54	2	1	2	2	1	3	4	1	3352	.279
54	3	1	2	1	5	1	1	1	547	.893
54	3	1	2	1	5	1	2	1	1392	.725
54	3	1	2	1	5	1	3	1	1961	.576
54	3	1	2	1	5	1	4	1	2902	.546
54	4	1	1	1	2	4	1	1	3459	.475
54	4	1	1	1	2	4	2	1	870	.808
54	4	1	1	1	2	4	3	1	2899	.681
54	4	1	1	1	2	4	4	0	0	1.000
54	5	2	2	1	3	6	1	1	2875	.482
54	5	2	2	1	3	6	2	1	2678	.252
54	5	2	2	1	3	6	3	1	4741	.639
54	5	2	2	1	3	6	4	1	5246	.289
54	6	2	1	1	4	2	1	1	4114	.402
54	6	2	1	1	4	2	2	1	2096	.378
54	6	2	1	1	4	2	3	1	1822	.811
54	6	2	1	1	4	2	4	0	0	1.000

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
55	1	1	2	3	4	2	1	1	2958	.570
55	1	1	2	3	4	2	2	0	0	1.000
55	1	1	2	3	4	2	3	1	5172	.465
55	1	1	2	3	4	2	4	1	4310	.087
55	2	1	2	2	3	1	1	1	3236	.463
55	2	1	2	2	3	1	2	1	2902	.426
55	2	1	2	2	3	1	3	1	3314	.284
55	2	1	2	2	3	1	4	1	4255	.334
55	3	1	2	1	1	4	1	0	0	1.000
55	3	1	2	1	1	4	2	1	725	.846
55	3	1	2	1	1	4	3	1	5778	.364
55	3	1	2	1	1	4	4	0	0	1.000
55	4	1	1	1	2	5	1	1	736	.854
55	4	1	1	1	2	5	2	1	412	.942
55	4	1	1	1	2	5	3	1	4115	.517
55	4	1	1	1	2	5	4	1	1928	.464
55	5	2	2	1	6	3	1	1	3521	.503
55	5	2	2	1	6	3	2	1	5197	.330
55	5	2	2	1	6	3	3	1	1243	.711
55	5	2	2	1	6	3	4	1	2486	.466
55	6	2	1	1	5	6	1	1	4280	.229
55	6	2	1	1	5	6	2	1	878	.755
55	6	2	1	1	5	6	3	1	5663	.569
55	6	2	1	1	5	6	4	1	3907	.470
56	1	1	2	3	1	2	1	1	2978	.567
56	1	1	2	3	1	2	2	0	0	1.000
56	1	1	2	3	1	2	3	1	882	.909
56	1	1	2	3	1	2	4	0	0	1.000
56	2	1	2	2	5	1	1	1	3589	.404
56	2	1	2	2	5	1	2	1	2922	.422
56	2	1	2	2	5	1	3	1	2294	.504
56	2	1	2	2	5	1	4	1	1490	.767
56	3	1	2	1	6	5	1	1	4202	.167
56	3	1	2	1	6	5	2	1	4895	.307
56	3	1	2	1	6	5	3	1	6281	.262
56	3	1	2	1	6	5	4	1	1971	.452
56	4	1	1	1	2	3	1	1	3728	.473
56	4	1	1	1	2	3	2	1	2561	.670
56	4	1	1	1	2	3	3	1	1902	.557
56	4	1	1	1	2	3	4	1	3314	.287
56	5	2	2	1	3	4	1	1	3935	.403
56	5	2	2	1	3	4	2	1	269	.941
56	5	2	2	1	3	4	3	1	2195	.759
56	5	2	2	1	3	4	4	1	1760	.589
56	6	2	1	1	4	6	1	1	4039	.273
56	6	2	1	1	4	6	2	1	2656	.258
56	6	2	1	1	4	6	3	1	6519	.503
56	6	2	1	1	4	6	4	1	6014	.185

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
57	1	1	2	3	6	3	1	1	3126	.559
57	1	1	2	3	6	3	2	1	7626	.017
57	1	1	2	3	6	3	3	1	2128	.504
57	1	1	2	3	6	3	4	1	3145	.324
57	2	1	2	2	5	2	1	1	4486	.348
57	2	1	2	2	5	2	2	1	1117	.669
57	2	1	2	2	5	2	3	1	4643	.519
57	2	1	2	2	5	2	4	1	1998	.577
57	3	1	2	1	1	6	1	1	3358	.395
57	3	1	2	1	1	6	2	0	0	1.000
57	3	1	2	1	1	6	3	1	4280	.674
57	3	1	2	1	1	6	4	1	2085	.717
57	4	1	1	1	2	1	1	1	3687	.388
57	4	1	1	1	2	1	2	1	3569	.295
57	4	1	1	1	2	1	3	1	2314	.500
57	4	1	1	1	2	1	4	1	5059	.209
57	5	2	2	1	4	5	1	1	4050	.197
57	5	2	2	1	4	5	2	1	5155	.270
57	5	2	2	1	4	5	3	1	5762	.323
57	5	2	2	1	4	5	4	1	2339	.349
57	6	2	1	1	3	4	1	1	4929	.252
57	6	2	1	1	3	4	2	1	2899	.361
57	6	2	1	1	3	4	3	1	5012	.449
57	6	2	1	1	3	4	4	1	1698	.604
58	1	1	2	3	2	6	1	1	3117	.439
58	1	1	2	3	2	5	2	0	0	1.000
58	1	1	2	3	2	6	3	1	5356	.592
58	1	1	2	3	2	6	4	0	0	1.000
58	2	1	2	2	3	3	1	1	1827	.742
58	2	1	2	2	3	3	2	1	5178	.333
58	2	1	2	2	3	3	3	1	3239	.246
58	2	1	2	2	3	3	4	1	3013	.352
58	3	1	2	1	6	4	1	1	2672	.594
58	3	1	2	1	6	4	2	1	145	.968
58	3	1	2	1	6	4	3	1	2112	.768
58	3	1	2	1	6	4	4	0	0	1.000
58	4	1	1	1	1	2	1	1	1841	.732
58	4	1	1	1	1	2	2	0	0	1.000
58	4	1	1	1	1	2	3	0	0	1.000
58	4	1	1	1	1	2	4	0	0	1.000
58	5	2	2	1	4	1	1	1	2667	.557
58	5	2	2	1	4	1	2	1	902	.822
58	5	2	2	1	4	1	3	1	1628	.648
58	5	2	2	1	4	1	4	1	3275	.488
58	6	2	1	1	5	5	1	1	4354	.137
58	6	2	1	1	5	5	2	1	4527	.359
58	6	2	1	1	5	5	3	1	6455	.242
58	6	2	1	1	5	5	4	1	1563	.482

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
59	1	1	2	3	6	2	1	5	7425	-.080
59	1	1	2	3	6	2	2	0	0	1.000
59	1	1	2	3	6	2	3	5	16416	-.700
59	1	1	2	3	6	2	4	0	0	1.000
59	2	1	2	2	4	3	1	1	5291	.253
59	2	1	2	2	4	3	2	1	7532	.029
59	2	1	2	2	4	3	3	1	1996	.535
59	2	1	2	2	4	3	4	1	3615	.223
59	3	1	2	1	5	4	1	1	5488	.167
59	3	1	2	1	5	4	2	1	3231	.288
59	3	1	2	1	5	4	3	1	5240	.424
59	3	1	2	1	5	4	4	0	0	1.000
59	4	1	1	1	3	1	1	1	4138	.313
59	4	1	1	1	3	1	2	1	3196	.368
59	4	1	1	1	3	1	3	1	1471	.682
59	4	1	1	1	3	1	4	1	3098	.515
59	5	2	2	1	1	6	1	1	3797	.316
59	5	2	2	1	1	6	2	5	7770	-1.172
59	5	2	2	1	1	6	3	1	5114	.610
59	5	2	2	1	1	6	4	1	6673	.095
59	6	2	1	1	2	5	1	5	6411	-.270
59	6	2	1	1	2	5	2	5	11307	-.601
59	6	2	1	1	2	5	3	1	8058	.053
59	6	2	1	1	2	5	4	5	12238	-2.404
60	1	1	2	3	1	3	1	1	4802	.322
60	1	1	2	3	1	3	2	0	0	1.000
60	1	1	2	3	1	3	3	1	1506	.649
60	1	1	2	3	1	3	4	1	2203	.526
60	2	1	2	2	5	6	1	1	4434	.202
60	2	1	2	2	5	6	2	1	1339	.626
60	2	1	2	2	5	6	3	1	11633	.114
60	2	1	2	2	5	6	4	1	3797	.485
60	3	1	2	1	6	1	1	1	1530	.746
60	3	1	2	1	6	1	2	0	0	1.000
60	3	1	2	1	6	1	3	1	2647	.428
60	3	1	2	1	6	1	4	1	5255	.178
60	4	1	1	1	2	2	1	0	0	1.000
60	4	1	1	1	2	2	2	1	2116	.372
60	4	1	1	1	2	2	3	1	3722	.615
60	4	1	1	1	2	2	4	1	1117	.763
60	5	2	2	1	4	4	1	5	8698	-.321
60	5	2	2	1	4	4	2	1	1346	.703
60	5	2	2	1	4	4	3	1	3541	.610
60	5	2	2	1	4	4	4	1	2672	.377
60	6	2	1	1	3	5	1	5	5393	-.069
60	6	2	1	1	3	5	2	5	7213	-.021
60	6	2	1	1	3	5	3	1	5502	.354
60	6	2	1	1	3	5	4	1	2296	.361

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SFR
61	1	1	2	3	3	3	1	1	5628	.290
61	1	1	2	3	3	3	2	1	6873	.114
61	1	1	2	3	3	3	3	1	603	.860
61	1	1	2	3	3	3	4	5	8681	-.666
61	2	1	2	2	2	6	1	1	3688	.336
61	2	1	2	2	2	6	2	0	0	1.000
61	2	1	2	2	2	6	3	1	5444	.585
61	2	1	2	2	2	6	4	5	8626	-.170
61	3	1	2	1	1	1	1	1	4922	.182
61	3	1	2	1	1	1	2	1	4589	.093
61	3	1	2	1	1	1	3	5	7668	-.657
61	3	1	2	1	1	1	4	1	686	.893
61	4	1	1	1	4	2	1	1	490	.929
61	4	1	1	1	4	2	2	1	2351	.302
61	4	1	1	1	4	2	3	1	2605	.730
61	4	1	1	1	4	2	4	0	0	1.000
61	5	2	2	1	5	4	1	1	3148	.522
61	5	2	2	1	5	4	2	1	787	.826
61	5	2	2	1	5	4	3	1	4163	.542
61	5	2	2	1	5	4	4	1	2837	.338
61	6	2	1	1	6	5	1	1	1949	.614
61	6	2	1	1	6	5	2	1	4635	.344
61	6	2	1	1	6	5	3	1	6650	.219
61	6	2	1	1	6	5	4	1	845	.765
62	1	1	2	3	3	4	1	1	3583	.456
62	1	1	2	3	3	4	2	1	2257	.502
62	1	1	2	3	3	4	3	0	0	1.000
62	1	1	2	3	3	4	4	0	0	1.000
62	2	1	2	2	6	5	1	5	5328	-.056
62	2	1	2	2	6	5	2	1	3076	.564
62	2	1	2	2	6	5	3	1	3682	.567
62	2	1	2	2	6	5	4	1	2361	.343
62	3	1	2	1	4	2	1	1	1313	.809
62	3	1	2	1	4	2	2	1	1900	.436
62	3	1	2	1	4	2	3	1	1587	.836
62	3	1	2	1	4	2	4	1	940	.801
62	4	1	1	1	5	6	1	1	3731	.328
62	4	1	1	1	5	6	2	1	1339	.626
62	4	1	1	1	5	6	3	1	6387	.513
62	4	1	1	1	5	6	4	1	1888	.744
62	5	2	2	1	2	1	1	1	1412	.765
62	5	2	2	1	2	1	2	1	3314	.345
62	5	2	2	1	2	1	3	5	5177	-.119
62	5	2	2	1	2	1	4	1	2785	.564
62	6	2	1	1	1	3	1	1	5197	.266
62	6	2	1	1	1	3	2	1	3276	.578
62	6	2	1	1	1	3	3	1	3898	.092
62	6	2	1	1	1	3	4	1	3389	.271

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
63	1	1	2	3	5	5	1	1	1061	.790
63	1	1	2	3	5	5	2	1	7039	.003
63	1	1	2	3	5	5	3	1	6476	.239
63	1	1	2	3	5	5	4	0	0	1.000
63	2	1	2	2	4	1	1	1	431	.928
63	2	1	2	2	4	1	2	1	3902	.229
63	2	1	2	2	4	1	3	1	3000	.352
63	2	1	2	2	4	1	4	1	5255	.178
63	3	1	2	1	3	6	1	1	5136	.075
63	3	1	2	1	3	6	2	0	0	1.000
63	3	1	2	1	3	6	3	1	9065	.309
63	3	1	2	1	3	6	4	1	615	.917
63	4	1	1	1	6	3	1	1	2636	.628
63	4	1	1	1	6	3	2	1	5084	.345
63	4	1	1	1	6	3	3	0	0	1.000
63	4	1	1	1	6	3	4	1	3898	.162
63	5	2	2	1	2	2	1	1	3800	.447
63	5	2	2	1	2	2	2	5	3644	-.081
63	5	2	2	1	2	2	3	1	1626	.832
63	5	2	2	1	2	2	4	0	0	1.000
63	6	2	1	1	1	4	1	1	4535	.311
63	6	2	1	1	1	4	2	1	1367	.699
63	6	2	1	1	1	4	3	1	3935	.567
63	6	2	1	1	1	4	4	1	3396	.208
64	1	1	2	3	3	5	1	1	3141	.378
64	1	1	2	3	3	5	2	0	0	1.000
64	1	1	2	3	3	5	3	1	3011	.646
64	1	1	2	3	3	5	4	5	6216	-.729
64	2	1	2	2	4	2	1	1	1861	.729
64	2	1	2	2	4	2	2	1	1215	.640
64	2	1	2	2	4	2	3	1	2880	.702
64	2	1	2	2	4	2	4	0	0	1.000
64	3	1	2	1	2	3	1	1	2900	.590
64	3	1	2	1	2	3	2	1	4482	.422
64	3	1	2	1	2	3	3	1	1356	.684
64	3	1	2	1	2	3	4	1	3352	.279
64	4	1	1	1	5	1	1	1	4883	.189
64	4	1	1	1	5	1	2	1	3746	.260
64	4	1	1	1	5	1	3	1	2600	.568
64	4	1	1	1	5	1	4	1	3569	.442
64	5	2	2	1	1	4	1	1	4639	.296
64	5	2	2	1	1	4	2	1	1139	.749
64	5	2	2	1	1	4	3	1	2982	.672
64	5	2	2	1	1	4	4	1	2796	.348
64	6	2	1	1	6	6	1	1	5027	.095
64	6	2	1	1	6	6	2	1	2832	.209
64	6	2	1	1	6	6	3	1	4961	.622
64	6	2	1	1	6	6	4	1	6673	.095

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
65	1	1	2	3	5	4	1	1	3314	.497
65	1	1	2	3	5	4	2	1	1470	.676
65	1	1	2	3	5	4	3	1	3065	.663
65	1	1	2	3	5	4	4	1	911	.787
65	2	1	2	2	2	1	1	1	2353	.609
65	2	1	2	2	2	1	2	1	3314	.345
65	2	1	2	2	2	1	3	1	1902	.589
65	2	1	2	2	2	1	4	1	4687	.267
65	3	1	2	1	3	3	1	1	3992	.436
65	3	1	2	1	3	3	2	1	2975	.617
65	3	1	2	1	3	3	3	1	1695	.605
65	3	1	2	1	3	3	4	1	3295	.291
65	4	1	1	1	4	6	1	1	4105	.261
65	4	1	1	1	4	6	2	1	966	.730
65	4	1	1	1	4	6	3	1	6058	.538
65	4	1	1	1	4	6	4	1	2349	.682
65	5	2	2	1	6	5	1	1	4830	.043
65	5	2	2	1	6	5	2	1	5177	.267
65	5	2	2	1	6	5	3	1	5870	.310
65	5	2	2	1	6	5	4	1	2166	.398
65	6	2	1	1	1	2	1	1	4800	.302
65	6	2	1	1	1	2	2	5	3526	-.047
65	6	2	1	1	1	2	3	1	2958	.694
65	6	2	1	1	1	2	4	0	0	1.000
66	1	1	2	3	1	6	1	1	2458	.557
66	1	1	2	3	1	6	2	0	0	1.000
66	1	1	2	3	1	6	3	1	3929	.701
66	1	1	2	3	1	6	4	1	3117	.577
66	2	1	2	2	2	2	1	1	4369	.365
66	2	1	2	2	2	2	2	1	1097	.674
66	2	1	2	2	2	2	3	1	1802	.813
66	2	1	2	2	2	2	4	0	0	1.000
66	3	1	2	1	5	3	1	1	1845	.739
66	3	1	2	1	5	3	2	1	3653	.529
66	3	1	2	1	5	3	3	1	3446	.197
66	3	1	2	1	5	3	4	1	2824	.393
66	4	1	1	1	6	4	1	1	3334	.494
66	4	1	1	1	6	4	2	1	994	.781
66	4	1	1	1	6	4	3	1	4349	.522
66	4	1	1	1	6	4	4	1	435	.899
66	5	2	2	1	3	1	1	1	2471	.590
66	5	2	2	1	3	1	2	1	2785	.450
66	5	2	2	1	3	1	3	1	4550	.017
66	5	2	2	1	3	1	4	1	3683	.393
66	6	2	1	1	4	5	1	5	5458	-.082
66	6	2	1	1	4	5	2	1	4635	.344
66	6	2	1	1	4	5	3	1	7711	.094
66	6	2	1	1	4	5	4	5	6303	-.753

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
67	1	1	2	3	6	4	1	5	8118	-.233
67	1	1	2	3	6	4	2	1	1491	.671
67	1	1	2	3	6	4	3	1	2817	.690
67	1	1	2	3	6	4	4	1	414	.903
67	2	1	2	2	1	2	1	1	1136	.835
67	2	1	2	2	1	2	2	1	1606	.523
67	2	1	2	2	1	2	3	1	1641	.609
67	2	1	2	2	1	2	4	0	0	1.000
67	3	1	2	1	2	1	1	1	1628	.730
67	3	1	2	1	2	1	2	1	2059	.593
67	3	1	2	1	2	1	3	1	1510	.674
67	3	1	2	1	2	1	4	1	2196	.656
67	4	1	1	1	5	5	1	1	931	.615
67	4	1	1	1	5	5	2	1	2902	.589
67	4	1	1	1	5	5	3	1	5393	.366
67	4	1	1	1	5	5	4	1	2123	.410
67	5	2	2	1	4	6	1	1	3336	.399
67	5	2	2	1	4	6	2	1	2327	.350
67	5	2	2	1	4	6	3	1	3775	.712
67	5	2	2	1	4	6	4	1	5246	.289
67	6	2	1	1	3	3	1	1	5028	.290
67	6	2	1	1	3	3	2	1	2674	.655
67	6	2	1	1	3	3	3	1	3389	.211
67	6	2	1	1	3	3	4	1	2467	.470
68	1	1	2	3	3	1	1	1	5589	.072
68	1	1	2	3	3	1	2	1	2530	.500
68	1	1	2	3	3	1	3	1	3530	.237
68	1	1	2	3	3	1	4	1	1294	.798
68	2	1	2	2	6	2	1	1	2782	.595
68	2	1	2	2	6	2	2	1	2174	.355
68	2	1	2	2	6	2	3	1	5524	.428
68	2	1	2	2	6	2	4	1	2488	.473
68	3	1	2	1	5	5	1	1	3076	.391
68	3	1	2	1	5	5	2	1	4873	.310
68	3	1	2	1	5	5	3	1	5437	.361
68	3	1	2	1	5	5	4	1	1884	.476
68	4	1	1	1	4	4	1	1	3459	.475
68	4	1	1	1	4	4	2	1	2899	.361
68	4	1	1	1	4	4	3	1	4515	.503
68	4	1	1	1	4	4	4	0	0	1.000
68	5	2	2	1	1	3	1	1	5084	.282
68	5	2	2	1	1	3	2	1	7400	.046
68	5	2	2	1	1	3	3	0	0	1.000
68	5	2	2	1	1	3	4	1	3182	.316
68	6	2	1	1	2	6	1	1	4061	.269
68	6	2	1	1	2	6	2	5	3995	-.117
68	6	2	1	1	2	6	3	1	6607	.497
68	6	2	1	1	2	6	4	1	5092	.310

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
69	1	1	2	3	2	3	1	1	2260	.681
69	1	1	2	3	2	3	2	1	5724	.262
69	1	1	2	3	2	3	3	1	1845	.570
69	1	1	2	3	2	3	4	1	2900	.377
69	2	1	2	2	1	5	1	1	1040	.794
69	2	1	2	2	1	5	2	1	4267	.396
69	2	1	2	2	1	5	3	1	4137	.514
69	2	1	2	2	1	5	4	0	0	1.000
69	3	1	2	1	4	1	1	1	2647	.560
69	3	1	2	1	4	1	2	1	2432	.519
69	3	1	2	1	4	1	3	1	1588	.657
69	3	1	2	1	4	1	4	1	2726	.574
69	4	1	1	1	3	4	1	1	2402	.635
69	4	1	1	1	3	4	2	0	0	1.000
69	4	1	1	1	3	4	3	1	1243	.863
69	4	1	1	1	3	4	4	1	21	.995
69	5	2	2	1	6	6	1	1	2107	.621
69	5	2	2	1	6	6	2	1	1097	.693
69	5	2	2	1	6	6	3	1	6234	.525
69	5	2	2	1	6	6	4	1	1119	.848
69	6	2	1	1	5	2	1	1	4467	.350
69	6	2	1	1	5	2	2	1	2214	.343
69	6	2	1	1	5	2	3	1	1900	.803
69	6	2	1	1	5	2	4	1	3311	.299
70	1	1	2	3	4	3	1	1	5310	.250
70	1	1	2	3	4	3	2	1	5818	.250
70	1	1	2	3	4	3	3	0	0	1.000
70	1	1	2	3	4	3	4	1	3728	.198
70	2	1	2	2	1	1	1	1	4706	.218
70	2	1	2	2	1	1	2	1	4255	.159
70	2	1	2	2	1	1	3	1	2628	.432
70	2	1	2	2	1	1	4	1	2020	.684
70	3	1	2	1	5	2	1	1	2801	.593
70	3	1	2	1	5	2	2	1	2508	.256
70	3	1	2	1	5	2	3	1	4055	.580
70	3	1	2	1	5	2	4	0	0	1.000
70	4	1	1	1	6	5	1	5	5783	-.146
70	4	1	1	1	6	5	2	5	8036	-.138
70	4	1	1	1	6	5	3	1	7754	.039
70	4	1	1	1	6	5	4	0	0	1.000
70	5	2	2	1	2	4	1	1	2320	.648
70	5	2	2	1	2	4	2	1	2858	.370
70	5	2	2	1	2	4	3	1	3479	.617
70	5	2	2	1	2	4	4	1	2630	.386
70	6	2	1	1	3	6	1	1	4346	.217
70	6	2	1	1	3	6	2	1	2019	.436
70	6	2	1	1	3	6	3	1	7726	.411
70	6	2	1	1	3	6	4	1	4280	.420

SUB	CON	BRE	SPE	CUE	FLY	MIS	TAR	RES	RANGE	SPR
71	1	1	2	3	6	6	1	1	3710	.332
71	1	1	2	3	6	6	2	1	3292	.080
71	1	1	2	3	6	6	3	1	9153	.303
71	1	1	2	3	6	6	4	1	4566	.381
71	2	1	2	2	5	5	1	1	3747	.258
71	2	1	2	2	5	5	2	1	3076	.564
71	2	1	2	2	5	5	3	1	5437	.361
71	2	1	2	2	5	5	4	0	0	1.000
71	3	1	2	1	4	4	1	1	2879	.563
71	3	1	2	1	4	4	2	1	3997	.119
71	3	1	2	1	4	4	3	1	2092	.770
71	3	1	2	1	4	4	4	0	0	1.000
71	4	1	1	1	3	3	1	1	4990	.295
71	4	1	1	1	3	3	2	1	3484	.551
71	4	1	1	1	3	3	3	1	1808	.579
71	4	1	1	1	3	3	4	1	3785	.186
71	5	2	2	1	1	2	1	1	3624	.473
71	5	2	2	1	1	2	2	1	1724	.488
71	5	2	2	1	1	2	3	1	2723	.718
71	5	2	2	1	1	2	4	1	2390	.494
71	6	2	1	1	2	1	1	1	2294	.619
71	6	2	1	1	2	1	2	1	3746	.260
71	6	2	1	1	2	1	3	1	2275	.508
71	6	2	1	1	2	1	4	1	4785	.252
72	1	1	2	3	5	1	1	1	2785	.537
72	1	1	2	3	5	1	2	0	0	1.000
72	1	1	2	3	5	1	3	1	1765	.619
72	1	1	2	3	5	1	4	1	3804	.405
72	2	1	2	2	4	4	1	1	4535	.311
72	2	1	2	2	4	4	2	1	2672	.411
72	2	1	2	2	4	4	3	1	3873	.574
72	2	1	2	2	4	4	4	1	538	.874
72	3	1	2	1	6	2	1	1	2723	.604
72	3	1	2	1	6	2	2	0	0	1.000
72	3	1	2	1	6	2	3	0	0	1.000
72	3	1	2	1	6	2	4	0	0	1.000
72	4	1	1	1	3	6	1	1	2985	.462
72	4	1	1	1	3	6	2	0	0	1.000
72	4	1	1	1	3	6	3	1	4807	.634
72	4	1	1	1	3	6	4	1	2919	.604
72	5	2	2	1	1	5	1	1	2383	.528
72	5	2	2	1	1	5	2	1	3985	.436
72	5	2	2	1	1	5	3	1	4809	.435
72	5	2	2	1	1	5	4	1	1516	.578
72	6	2	1	1	2	3	1	1	5028	.290
72	6	2	1	1	2	3	2	1	4952	.362
72	6	2	1	1	2	3	3	1	1827	.575
72	6	2	1	1	2	3	4	1	4237	.089

ANNEX B

SEEKVAL

PROJECT IA2

DIRECT VISUAL IMAGERY EXPERIMENTS

PROJECT MANAGER'S REPORT

1. Introduction and Purpose. This report by the project IA2 manager is intended to provide an interface between these results and other SEEKVAL projects. The project manager and the independent contractor analyst reviewed and evaluated technical progress continuously during data collection and analysis, hence this report should provide interfacing information of use in evaluation by Joint Test Force analysts. The discussions presented in this report reflect the opinion of the project manager but have been reviewed and discussed with all contractor analysts.

2. Discussion. The project manager agrees with the contractor's conclusions as stated. Points which should help clarify the meaning of conclusions to Project SEEKVAL are discussed below. Specific discussions which lead to recommendations are reserved for the recommendations paragraph because the logical development of the recommendations are occasionally complex. This structure should allow easier evaluation of the recommendations.

a. Two performance measures were available for use as criterion (independent) variables in the regression analyses: Search Performance Ratio (SPR) and weighted Mean Acquisition Range (ACQR). The SPR is a function of a target's maximum visual availability range (MAR) and serves to remove data variability solely due to differences in visual availability ranges among a given set of targets. The SPR technique transforms all acquisition range data to a uniform, dimensionless scale defined in the interval 0.0 to 1.0 (see Sect. 4.a.(1) of Annex A). The MAR is a composite measure of all ground scene, flight-related, and simulator characteristics which establish a limiting range-to-target for meaningful acquisition. Details regarding its derivation are discussed on Sect. 3.f.(3) of Annex A. The MARs for the IA2 target set were established by a group of qualified target acquisition research specialists using the Boeing Multimission Simulator. The decision was made to use ACQR as the regression dependent variable because this permitted the evaluation of MAR as a predictor variable, which would not have been the case when using SPR, since SPR is directly a function of MAR.

b. In describing target and background effects it is assumed that some decision criterion can be applied that defines which terrain variables are part of background effects and which are not. Earlier methodological work had defined masking as outside the set of background variables. In the imagery for this experiment masking effects could not be eliminated on four of the 24 Oklahoma targets. We were able to determine that no bias due to these specific masking effects occurred in this experiment; however, an attainable and meaningful decision criterion for this distinction which can be applied generally remains to be found.

c. The purpose statement included the implication that the value and validity of the simulator approach will be determined from this experiment. While the data and results of this experiment will contribute to this evaluation no final conclusions should be made until the field experiment results are also available.

d. While the value of the simulator methodology cannot be addressed in this report, the power and potential of the empirical approach to the target acquisition problem is well demonstrated. The good predictive results, the clarity with which methodological improvements can be defined, and the potential for eventual taxonomy of target and background related variables shown in the experiment are meaningful proof of the value of the empirical approach as an addition to the analytical approach.

e. While the results of the dynamic experiment on flight variables are of direct use and should be used to eliminate variables in further SEEKVAL experiments, the results of the predictive methodology are not directly usable. The predictive methodology can be applied usefully without improvement to following SEEKVAL studies. Refinements and improvements are recommended, however, which may increase both the predictive power of the methodology and the insights to be gained. These should be accomplished as the value to SEEKVAL could be high. In any case a predictive methodology like this one must be applied to IC2 imagery if an improved ability to treat target/background effects is to be gained.

f. An expected and obtained result in this experiment is that, while the methodology predicted only one target order, the obtained target order varied across flight condition cells. How flight related variables interact with target/background variables requires investigation if a single scale on target/background effects is to be achieved.

g. One important way in which it is desirable to apply these results is in measuring complexity, the combination of target/background variables. A good scale depends on very high correlation. This appears to be accomplishable, but will also require further effort in refining the methodology.

h. The imagery, some of the dependent variables, and several of the independent variables considered in IA2 would be inappropriate for treatment of target acquisition from the pop-up and nap-of-the-earth (NOE) mission profiles. Imagery representing these rotary wing profiles will be collected in IC2, and the IA2 methodology will have to be modified, or new methods will have to be determined to treat these differences. Because rotary wing mission profile imagery was not available to this experiment, it was beyond the capability of IA2 to

develop a methodology for treatment of rotary wing target acquisition, but some of the problems that will have to be addressed have become apparent. Two side tests on complexity and ambiguity show that no significant differences exist between rotary and fixed wing observers in the understanding of observer task statements. Nevertheless, the two groups will have to be treated by different measures as will be discussed below. As a result, it may be impossible to meaningfully relate performance of the two groups, or target/background effects as they appear in dynamic imagery representations of the differing mission profiles. The following measures used in IA2 are either inappropriate or require modification before they will be measures of rotary wing target acquisition performance:

(1) Weighted Mean Acquisition Range (ACQR). Range is a preselected variable in pop-up. Time from unmask to acquisition would be a better measure. Range is a controlled variable in NOE, but the repetition of mask/unmask events typical of NOE may confound range at acquisition as a measure of target acquisition performance. Probability of acquisition may be the only measure of performance that can be applied across rotary wing conditions, but more sensitive measures should be sought.

(2) Maximum Available Range (MAR) may be a useful predictor of performance for rotary wing profiles, but there may be difficulty in using it because MAR is measured in range and rotary wing performance may have to be measured in time with no clear relationship to range.

(3) Search Performance Ratio (SPR) as a ratio of ranges may not be usable for rotary wing studies. It may be possible to define a new search performance ratio in terms of time for pop-up and time or range-weighted intervisibility time for NOE.

(4) Static Detection Time. For pop-up this may be an excellent predictor, and will require only one frame presentation per encounter. For NOE it may be possible to time-correlate the sequence of scenes with each interscene period representing the time length of masking for the specific encounter.

(5) Paired Comparison and Object Count. If refinements of these research techniques yield higher correlations for the fixed wing profile it should be expected that corresponding treatment of rotary wing profile scenes should correlate equally well.

3. Recommendations. This paragraph is organized by grouped objectives of the experiment because the exploratory nature of the project resulted in several nearly independent sets of objectives.

a. Objectives 1-4. These objectives relate to the predictiveness of static and, by assumption, physical measures, and a methodology to obtain a best combined prediction. All recommendations pertaining to these objectives are grouped into the following categories: Refinement of predictive methodology analysis, refinement of existing measures, and new measures.

(1) Refinement of predictive methodology analysis:

(a) Target Expectation: The "target-like object" conceptual definition underlying the choice of measures in this experiment clearly implies the participation of the target itself in selecting actual from potential target-like objects in the scene. The combination of results of this experiment tend to support this implication. It appears that, as implied in the conceptual definition, scene complexity is highly specific to the target expected by the observer as well as to the existing clutter or heterogeneity of the terrain at the target site. This could be termed the target expectation of the observer; prebriefing, for example, would influence the precision of the observer's target expectation. If it is appropriate to consider all of the observer's target acquisition experience as dimensional with prebriefing, then in any target acquisition event, the observer appears to respond to the scene in terms of target-like objects based on his experience and prebriefing. Put another way, the more specific the observer's knowledge is of his expected target, the fewer actual objects will be perceived as target-like and the less his sensitivity to "clutter". Establishing the relative importance of the combined effect of target parameters in scene complexity would be a valuable step in a taxonomy of target background variables and could lead to a better ability to analyze target, background and flight condition interactions. It is possible for target and background parameters to impact on observer performance only through perception or expectations and, before the target is acquired, target parameters can only be expected. Hence, target expectation is a useful concept in dealing with the target background parameter relationship. This work appears to be within the capability and charter of SEEKVAL, and would add to the sensitivity of further SEEKVAL work by clearly identifying methodological ground rules for further observer testing.

The results which led to this concept are:

- MAR, which should depend heavily on target parameters rather than background parameters, was the factor which accounted for about 75 percent of the variance due to other than controlled variables, implying the importance of the target itself in the prediction of performance.

- Static Detection Range, in which the observer was prebriefed on the exact target, as well as its background, was the next most influential factor in the prediction of performance.

- Paired Comparison for ease of detection judgments, while highly reliable was not predictive, and had good but not excellent discrimination. In this test the observer was told to imagine he was looking for any of a broad range of targets from individual mortar emplacements up to groups of large vehicles.

- Of the variables tested in the dynamic study, that with the largest effect on performance was prebriefing levels.

These results from IA2 neither prove nor disprove the value of the target expectation concept for two reasons:

- The effects on MAR of phenomena other than target parameters has not been established, hence MAR is a probable, but not proven, perceptual measure based on target effects.

- Experiment results do not show the unconfounded effect of specific versus vague target expectation on either performance or perceived complexity in the range of expectation before briefing.

To test the hypothesized importance of target expectation, field experiment validation of MAR under significantly different levels of atmospheric attenuation with simultaneous imagery collection should be undertaken. Simulator determination from this imagery of MAR compared with field experiment MAR and determination of real atmospheric attenuation effects would isolate the differential effects, if any, of simulator attenuation, and insure that MAR is a clear measure of the grouped effect of target parameters on target acquisition performance. Once full confidence in MAR as a measure of perceived target parameter effects is established then the real value to be gained here, the impact of target parameters and how they are filtered by the observer in his target expectation, can be examined.

To test the impact of target expectation on perceived complexity a limited experiment comparing levels of target specificity in observer instructions with paired comparison scene ordering could be undertaken at relatively small expense. Differences in order or discrimination would show an effect due to target expectation. The strength of these offsets would be implied by the changes in correlation of the paired comparison response with ACQR induced by changes in target expectation specificity.

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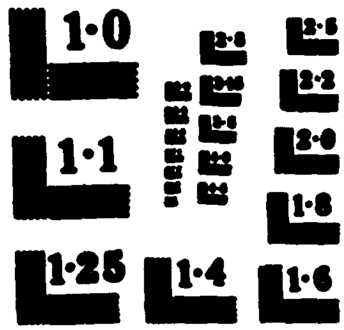
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2·2
2·5

(b) Operational Weighting of Terrain: An indexing scheme that would characterize search difficulty based on military consideration of vegetation and terrain by proportionate areas appearing within a speed and altitude related search window may be useful to enhance existing overall predictiveness. The underlying thought here is that the military situation (attack, defense, support, etc.) may provide certain broad cues by which the observer preselects as cues certain broad areas such as ridge lines for defensive positions, hilly terrain for infantry targets and valley floors for attacking armor. Empirically determined weights for such areas, defined from a precise scenario may usefully sensitize predictors and, at the same time, provide information above the effects of the military scenario on perceived complexity.

(2) Refinement of existing measures:

(a) Fewer subjects should be considered for use in future static tests. Reliabilities of 0.90 could have been realized by reducing the sample size from 100 to 10 for the paired comparison test and from 100 to 17 for the ambiguity test.

(b) Instead of using as many as ten static scenes for each encounter, fewer scenes should be considered. This would maintain an adequate reliability level and permit complete and manageable analyses such as full paired comparisons for all cells.

(c) If paired comparison techniques on perceived complexity are included in a refined methodology, they should be designed so that a full paired comparison data set can be collected and Guilford's application of Thurstone's Law (Psychometric Methods, 1954) can be applied to improve the interval qualities of the paired comparison scale.

(d) Instructions for future target-like object counts should differentiate between distraction points (target-like objects that degrade acquisition) and cues (areas in which targets are likely to occur and which enhance acquisition). Both counts when properly differentiated are expected to contribute to predictiveness.

(e) Additional pilot studies should be conducted in future static tests to explore sensitivity to task definitions and to assure greatest sensitivity to responses.

(f) Existing measures on background effects (paired comparison and ambiguity) should be sensitized by permitting subjects to view only a search window portion of the entire field of view. This search window would be bounded at the near edge by scan limitations, at the far edge by potential visual resolution of target subtenses, and at

side edges by expected deviation from observed flight path heading. This technique may better define a static imagery target area search that corresponds to what is realistically scanned by observers participating in dynamic imagery simulator tests.

(g) In the psychophysical measures, observers should be briefed for specific tactical targets before judging scenes if responses are to be correlated to dynamic performance after prebriefing. Interaction of the expected target and its background may be important and should be controlled so that the observer can sensitize his search capability. Some of the low correlations that resulted may be attributable to lack of control of target expectation.

(h) Encounters foreshortened by intermediate range masking should either be treated systematically or avoided. Such masking truncates the potential range at which targets can be acquired, thereby confounding target and near target-scene effects with masking effects.

(i) It is possible that the low correlations between target parameters and MAR are due at least in part to the measurement techniques or to the definitions used. Dimensions were measured from static film, but could be established analytically from available data, thus removing some possible measurement error. Luminance was measured from the film with a photometer, but luminance measurement has not been successfully refined to a standard procedure. Contrast was determined from luminance measures, but the definition $\frac{B_t - B_b}{B_b} = C$ may not be valid. This definition is bounded at -1.0 as long as the target is darker than its background but is unbounded for targets lighter than their background. A possible replacement definition is

$$\left.\begin{array}{l} \dfrac{B_t - B_b}{B_t} \; ; \; B_t > B_b \\[2ex] \dfrac{B_t - B_b}{B_b} \; ; \; B_b > B_t \end{array}\right\} = C$$

This definition would bound contrast between -1.0 and 1.0 for all cases.

(j) It is possible that low correlations between target parameters and MAR occurred because the measures taken do not reflect the parameters of greatest importance, because interactions among parameters are more important to acquisition than main effects, and because parameters other than target parameters reduce the value of MAR as an aggregate measure of target parameter effects. Or any

combination of the above may have caused the low correlation of target parameters to MAR.

(k) Measurement of MAR as an independent variable and predictor requires further analysis and refinement. Because MAR was originally expected to be a deterministic component of the dynamic performance measure, it was collected by a panel of experts making frame by frame consensus judgments. If it is to be used as an independent variable again, it should be collected from the military observer population and it should be collected as independent judgments so variance in response can be recorded and used.

(3) New Measures: Experience and knowledge gained in conducting Project IA2 allows us to hypothesize several new potential measures of complexity, in addition to identifying improvements on the static measures tested in IA2. The following new measures are the result of analysis to date, but are not exhaustive. Further analysis of IA2 results should identify more inferences which can be tested by hypothesizing other measures of complexity. One specific investigation which looks fruitful would be comparison of the group of poorly predicted encounters with well predicted encounters to identify any factors common to one group but not the other.

(a) Cue Count: Experimenters in target acquisition have long felt intuitively that objects in a scene may either degrade target acquisition performance (target-like objects) or enhance it (cues). The unexpected reversal in correlation sign between the paired comparison and object count measures, and subsequent identification of unintended emphasis on cues in the object count study suggest that an observer count of cues may be a useful predictor of target acquisition performance, and possibly of complexity. Such a cue count study should not necessarily replace the target-like object count, rather, both counts together may allow us to more fully reflect the potential contribution to complexity of objects in the scene.

(b) Physical Target-like Object Count: IA2 measured target size, target-background brightness contrast, and background luminance. None of these measures correlated well with obtained mean acquisition range or with maximum available range, which intuitively should depend heavily on target parameters. It can be inferred that either some other parameters are the biggest contributors to MAR or that interactions among these effects are more important than the effects themselves. The latter hypothesis could be tested by a variation on the computer driven micro-densitometer line scan done by Zaitzeff (Reference 10). Zaitzeff's technique counted bright objects as defined by luminance above a computed floating average luminance of a size about that of a target of interest, but did not correlate well. If the target-like object hypothesis defining complexity is

correct, then Zaitzeff may simply not have been counting the occurrence of a phenomenon that is important in the operational world. In the operational world, equipment, paints, and camouflage are all designed to reduce the effect of brightness, hence a measure of luminance difference might be more meaningful. The target size and contrast main effects plus interaction might be measured by modifying Zaitzeff's mechanized procedure, the micro-densitometer would sweep incrementally across range bands, perhaps at an optimum range band about the 60 percent MAR range for each scene, and conduct an object count driven by an algorithm which requires first, an incremental luminance change in the same sign and greater than some empirically determined luminance change; second, maintenance of the new luminance level for a width not less than the smallest predetermined target width nor larger than the greatest predetermined target width; and third, an incremental luminance change of opposite sign and greater than the empirically determined luminance change. The intended result of such a study would be a count of only those objects in a scene which are in the most productive search range band, are similar to the expected target in lateral size and as attractive or more attractive than the expected target in luminance difference.

(c) Observer comparison of single static imagery frames at the range of expected maximum detection rate may disclose relationships not otherwise discernible. Rank ordering such scenes by judged difficulty may suggest additional factors bearing on scene complexity. For example, target related cues about the target may increase the apparent subtense and facilitate earlier acquisition. Rationalizing difficulty by visual examination of the entire target array by experienced observers or by photo-intelligence specialists may prove to be a fertile means of discovering additional physical measures. In addition, acquisitions occurring as a result of larger peripheral cues that extend the target area subtense could be examined.

b. Objectives 5-6: These objectives address the effects and interactions of flight related variables.

(1) The test design matrix did not allow for investigation of prebriefing by real time cueing interactions. Such interactions would be of interest in following the concept of target expectation. If work on target expectation is to be undertaken, then these interactions should also be investigated.

(2) There is a possible interaction between encounters and flight conditions implied by the change of correlations of the predictive methodology to obtained performance as conditions varied. This kind of interaction deserves special attention, but analysis will depend on a good interval scale on target/background effects. Further, data collection designs should allow investigation of these interactions and a scale on scene complexity should be provided.

(3) No significant briefing by speed interaction was found. Future test designs may therefore be simplified by assuming no interaction.

c. Objective 7: This objective addresses the correlations between obtained performance and physical measures. Recommendations on physical measures have already been discussed in paragraph 3a.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A series of four experiments were conducted (Dynamic Imagery, Complexity, Ambiguity and Static Detection) in the course of developing a suitable methodology for measuring the effects of target/background characteristics on visually unaided target acquisition performance under varying flight operations. In the Dynamic Imagery Study 72 military aircrews searched for 24 small tactical targets (distributed over 6 missions) under various combinations of simulated airspeed, briefing levels and inflight target cueing, by "flying" a fixed based, motion-picture based simulator. The results showed marked

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performance improvement due to briefing level (photos vs no photos) and relatively less improvement with Forward-Air-Controller cueing, and reduction of airspeed from 360 kts to 220 kts. In the Complexity study different aircrews judged the relative search-scene difficulty of the 24 target encounters. In the Ambiguity study another set of aircrews counted the number of "cues and target-like" elements in the search scenes. Finally, the Static Detection study evaluated target acquisition performance under the condition where flight dynamics are eliminated. Results from all four studies were subjected to regression analytic techniques using 10 predictors for estimating the performance under the various experimental conditions. Multiple correlations ranged from 0.77 to 0.99. Maximum available range (MAR), a composite measure of all ground scene, flight-related, and simulator characteristics which establishes a limiting observer-target range for meaningful acquisitions, proved to be the most powerful performance predictor. The implications for other SEEKVAL projects and recommendations for future research are discussed.

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